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THE ARROW POINT SPEARHEADS AND KNIVES OF PREHISTORIC TIMES.

PROF. Thomas Wilson, Curator of the Division of Prehistoric Archæology, of the National Museum, has recently published in the 1897 report of the United States National Museum, a paper entitled "Arrow Points Spear-Heads and Knives of Prehistoric Times," which is beautifully illustrated by over two hundred illustrations and sixty plates. Space forbids us to do more than glance at a few of the facts which he adduces.

The arrow points spearheads and knives of prehistoric races were made of stone, and they have such a likeness of form and style that a sharp line of division between them is impracticable. A small implement may be an arrow head, while a large one of the same type might be a spearhead, while either or both may have served as knives. The spear belongs to an earlier epoch in man's civilization than does the arrow, although they are similar in operations they differ greatly in age. The first implements known to be used by man were rude, heavy thick flints which belong to the Chelléen epoch of the paleolithic period. They were probably never used with a handle; for it is hard to conceive an implement so ill-contrived for attachment to a handle. It is probable that at this period the inventive genius of man had not been yet able to discover and employ a handle that could be attached to these or similar implements without its being open to certain objections as owing to their shape they could not be sufficiently inserted in the wood and would fly out. In the middle part of the paleolithic period an implement appeared which we may well suppose to have been the head of a spear or javelin. From this time the processes of manufacture appear to have increased remarkably, largely owing to the invention and evolution of the bow and arrow. Prof. Wilson gives an elaborate account of the origin and invention of the bow and arrow, dealing with its mythology, its history and its archæology. He illustrates a large number of types of the arrow heads. He then discusses the material of the arrow points and spearheads with a special view to their petrography, and then takes up the question of scrapers, grinders and straighteners used in making arrow and spear shafts, this is in turn followed by the classification of arrow points and spearheads, dividing them into leaf-shaped, triangular stemmed and peculiar forms. He then deals with the question of knives and we present an engraving showing the manner of holding what are termed hump-backed knives. Two of them are held in the hand so as to present the cutting edge, as each implement has only one rounded edge sharp enough for use and could be used only when held in the hand after the manner of a fish-knife. Possibly these implements were used ambidextrously and furnished evidence of the right and left-handedness on the part of prehistoric man. It is certain that the shape of an occasional implement fits the left-hand better than it does the right. Certain humps are not in the center but are to one side, sometimes to the right and other times to the left, while the manner of grasping them in the hand, as shown in Fig. 1, demonstrates that they are more easily manipulated and more effective when used right and left-handed respectively, than when used indifferently. It has been suggested that these implements were only accidents or failures made by the aboriginal workmen when endeavoring to make the usual leaf-shaped instrument, but this is not regarded as a correct deduction. It would be foolish to assert, however, that there were no accidents or failures in the prehistoric quarry or workshop. At Piney Branch, near Washington, D. C., they were to be dug by the hundreds of thousands and to be measured by the ton. Prof. Wilson then deals with the wounds produced by arrow points or spearheads, and it seems as though military surgery had its origin in the treatment of wounds inflicted by arrows and spears, and he cites various classical authors.

MANNER OF HOLDING "HUMP-BACKS" FOR USE AS KNIVES.

Our other engravings represent flint disks made from the concretionary flint nodules and the collection of chipped flint disks cached in or mined on the Hopewell farm.

CHIPPED FLINT DISKS AT HOPEWELL FARM, ROSS COUNTY, OHIO.

AUSTRALIAN OYSTERS.

AUSTRALIAN oysters are cheap and plentiful, being retailed in shilling per plate enormous, lasting throughout the year, and amounting to several millions of bivalves annually. The whole of the New South Wales coast is admirably adapted for oyster culture. The climate, the nature of the coast-line, with its innumerable inlets and creeks, and the natural existence in several varieties of the bivalve itself, all combine to mark its suitability for the culture. Unlike the coasts of Great Britain, and even America, where the temperature during the summer months is frequently sufficient to prevent the shedding of spat, and generally to limit its quantity, the spat in New South Wales is distributed in unlimited profusion, and were due advantage taken of these favorable conditions, New South Wales oysters might become a leading article of oversea export. Their very abundance, and the ease with which they are gathered, forms a real cause of trouble. The equipment for a Sydney harbor picnic would be considered incomplete without the means of detaching oysters from the rocks, on which they are found in myriads. Until about thirty years ago, there was nothing done to conserve this source of food supply. The oysters were collected by whole

sale, without any steps being taken to secure a continuance of the supply. The natural results followed, and legislation became necessary to secure the preservation of the oyster fisheries; but much remains to be done.

At the present time, for the purpose of oyster culture, the Colonial Government grants leases of the foreshores of tidal waters, which may be defined as between the mean high and mean low water mark. The rental is 20s. per annum for every 100 linear yards. The maximum length, for which a lease may be obtained, is 2,000 yards; but as the same person may take out more than one lease, the portion of shore which may be required is practically unrestricted by the Colonial Oyster Fisheries Act. The lease may be taken for a term of ten years. Leases of deep water or natural oyster beds are also granted for an area not exceeding 25 acres, at a rental which must not be less than £2 per acre. Owing to bad management, the oyster beds of Port Jackson, Port Stephens, the Hawkesbury, and the Shoalhaven became greatly injured, so that the markets of Sydney have to depend upon the beds of the Manning, the Richmond, and other northern rivers, as well as places beyond the colony, for their supply of oysters. The appointment of a Fisheries Commission in 1880 probably prevented the entire extinction of the oyster industry in New South Wales, though the operations of the commission have been much impeded from lack of sufficient legislation to enable them to check the improvidence of the lessees, who, with few exceptions, strip the oyster beds without regard to future supply.

There is but little doubt, says Mr. Coghlan, the New South Wales Government statistician, that the establishment of "pares," like those which may be seen along the coasts of France and Belgium, where oyster culture is conducted on scientific principles, would be remunerative, as the demand for this delicacy is great, and continually increasing. There is, indeed, a wide field for remunerative employment in this direction, and experts in the art of oyster culture would find every possible facility placed at their disposal. During the year 1897, 14,701 bags of oysters were obtained from the tidal waters of the colony, being a satisfactory increase on the takes of previous years; while in addition to this supply, 2,767 bags of oysters were imported from other colonies, their value being set down at £3,103. In 1898, the quantity imported was 7,110 bags, value £5,322; of which 6,236 bags came from New Zealand, 550 bags from Queensland, 282 bags from South Australia, 30 bags from Victoria, and 12 bags from Tasmania. A bag of oysters contains 3 bushels, and at the beginning of 1899 the price per bag of good oysters in Sydney ranged from 35s. to 40s.

[Continued from SUPPLEMENT, No. 1260, page 20206.]

CRUISE OF THE "ALBATROSS."—III.

MR. AGASSIZ'S third letter written from the "Albatross" to Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, is dated Suva Harbor, Fiji Islands, December 11, 1899, and is as follows:

We left Papeete, November 15, after coaling and refitting on our return from the Paumotus. During our trip to Suva we made a few soundings from Tahiti to Tonga, striking the northern extension of the deep basin lying to the eastward of Niue; the depths ranged from 2,473 to 2,882, the bottom being red clay. This would indicate a greater extension westward of the zone over which the manganese-nodule bottom extends.

After leaving Niue we steamed for the deep hole of the Tonga-Kermadec Deep, about 75 miles to the eastward of Tonga-Tabu, and in 4,173 fathoms made a haul with the Blake beam-trawl, by far the deepest trawl haul yet made. The gear was carefully inspected and strengthened as far as practicable by Captain Moser, and it was with considerable anxiety that we laid out 5,000 fathoms of wire rope for our haul. Fortunately, everything went off successfully and we landed the trawl safely back on deck. To my great surprise we found in the bag a number of large fragments of a silicious sponge belonging probably to the genus Crateromorpha which had been obtained by the "Challenger" in the Western Pacific, but in depths less than 500 fathoms. We also brought up quite a large sample of the bottom; it consisted of light brown volcanic mud mixed with radiolarians.

We decided to trawl at 4,173 fathoms rather than wait for a possibly deeper sounding, as the conditions for work were admirable and we did not care to run any risk from a change of weather. After our haul we made a still deeper sounding in the proximity of the 4,762-fathom sounding marked on the chart, and found 4,540 fathoms with the bottom of the same character as at the place where we trawled. We also took a couple of soundings in the line from Vavau to the southern extremity of the Lau Group in Fiji, but found, as we expected from the soundings given further south comparatively shoal water, viz., 1,381 fathoms. In the channel north of Yangasá where we crossed the Lau plateau between Yangasá and Mothe, we found 453 fathoms, with bottom composed of coral sand, pteropod ooze and a few globigerinas. Between Namuka and Yangasá we obtained 324 fathoms, between Namuka and Marambo 600 fathoms, and between it and Kambara 450 fathoms, and finally about 15 miles west of Kambara we sounded in 990 fathoms. These sounding would indicate a continuous plateau of moderate depths from Wailangolala south upon which the islands of the Lau Group rise.

On our way back to Papeete from the Paumotus we examined the eastern coast of Tahiti, and from Papeete examined the western coast as far as Port Phaeton at Tararao Isthmus. We examined in a general way the Leeward Society Islands: Murea, Huaheine, Raiatea, Tahaa, Bora-Bora, Motu Iti and Maupiti. There are excellent charts of the Society Islands, so that it was comparatively simple to examine the typical points of the group and to gain an idea of their structure as far as it relates to coral reefs. The Society Islands are all volcanic islands edged with shore platforms, some of great width, upon which the barrier or fringing reefs of the islands have grown. The structure of the reefs of the Society Islands is very similar to that of the Fiji reefs round volcanic islands. A comparison, for instance, of the charts of Kandavu, Viti Levu, Mbengha, Nairai, and of other volcanic islands in the Fijis, with those of the Society group, will at once show their identity. Huge platforms of submarine denundation and erosion characterize both, with fringing and barrier reefs determined by local conditions. Perhaps it is easier to follow the changes which have taken place in the Society Islands; and such islands as Tahaa and Bora-Bora, where we anchored, as well as Maupiti, are admirable examples and epitomes of the structure and mode of formation of the coral reefs of that group.

In Motu Iti and Tetuora the volcanic peaks have disappeared, leaving nothing but a shallow platform upon the outer edges of which sandy coral islets have been thrown up. There is, however, one point in which the barrier reefs of the Society Islands differ from those of Fiji. The barrier reefs in Fiji are generally indicated merely by reef flats, upon which the sea breaks, and an occasional rocky islet or negro-head; only rarely do we find sand keys upon the fringing reefs of the islands of Fiji. In the Society Islands, on the contrary, we find the line of the barrier reef usually well indicated by long lines of narrow islets thrown upon the reef platforms, exactly as they are in the Paumotus. These islands and islets are usually well wooded, and thus give a very peculiar aspect to the barrier reef. In the case of Bora-Bora, Maupiti and Aitutaki, for instance, we have a central volcanic peak of considerable height surrounded by a wide lagoon, the sea edge of which is formed by a fringe of wooded islets and islands forming a more than half-closed ring around the central island which, in Bora-Bora and

FLINT DISKS MADE FROM CONCRETIONARY FLINT NODULES.

Maupiti, rise in slopes and nearly vertical walls, the former to a height of nearly 2,400 feet, the other about 1,100 feet.

The only island of the Cook group which we examined was Aitutaki, as Atiu is composed of elevated limestone, and Rarotonga is volcanic. I hoped we might find that atoll to be in part volcanic and in part composed of elevated coralliferous limestone; we found it to be volcanic, an island with the structure of Bora-Bora on a smaller scale.

We anchored at Niue, an island composed of elevated coralliferous limestone showing three well-marked terraces, the lowest of not more than 5 to 10 feet and in many places disappearing completely, the limestone cliffs rising vertically from the sea well into the second or even the third terraces. The vertical faces of the cliffs are dotted with caverns and deeply indented by small cañons extended at right angles to the face of the shore or forming blunt headlands separating short reaches of coral sand beaches. The second terrace varies in height from 50 to 60 feet, the third from 90 to 100 feet. The second terrace is deeply undercut; and in the higher vertical cliffs extending into the third terrace from the sea, the former positions of the terraces are usually indicated by lines of caverns. There are corals on the sea slopes of the first terrace extending to 10 or 12 fathoms growing much as they are found at Makatea.

From Niue we went to the Tongas, which we found a most interesting group. The elevated tertiary coralliferous limestones take here their greatest development, and are on a scale far beyond that of their development in the Lau Group of the Fijis or the Paumotus. The first island of the Tongas we visited, Eua, is perhaps the most interesting of the islands composed of tertiary elevated coralliferous limestone I have visited. From Dana's account of it, evidently given at second hand, I expected to find an island somewhat like Viti Levu on a very much smaller scale. But as we steamed up to it from the east there could be no mistaking the magnificent face of nearly vertical limestone cliffs forming the whole eastern face of the island, and at points rising to over a thousand feet in height. At all projecting points lines of terraces were plainly marked; at the northern point three could be followed, and at the southern extremity five, with perhaps traces of a sixth.

Upon rounding the southern extremity of the island we could see that the island was composed of two ridges, running north, separated by a deep valley, the western ridge being much lower than the eastern, not rising to a greater height than a little over 500 feet. The western ridge is also composed of limestone, and at the headlands we could trace three terraces. There is a narrow shore-platform along the western face, at many points of which there are blow-holes where the sea throws up spray to a considerable height, but these blow-holes are best seen off Cook Point, the southern extremity of Tonga-Tabu.

As we steamed along the western face of Eua Island, we could see the ridges of the eastern side rising above the crests of the lower ridge, its slopes indicating a valley of considerable size. We anchored at English Roads, opposite the outlet of the drainage of the interior basin where a small river has cut its way through a depression in the shore terrace. On landing we followed the crest of the western ridge for a few miles and could see the whole valley forming the basin of the island lying between the two ridges, at our feet; the slopes leading to the bottom are quite gentle, and the valley dips very gradually northward back of the outlet, on the western shore. Nothing could show more clearly that such an island was not an elevated atoll, but a plateau which has been eroded and denuded for a long period of time by atmospheric and other agencies, and in which a deep basin-shaped valley with gentle slopes has been gouged out—a plateau similar to that of Tonga-Tabu Island and of Vavau, but of greater height and less extent.

To the westward of the Tonga Islands is a line of volcanic islands extending nearly 200 miles from Honga Hapai to Fanualai, some of which have been active very recently. Falcon Island disappeared in 1898, and Lette is still active. This line of volcanoes runs at a distance of from 15 to 20 miles parallel with the trend of the four irregularly shaped plateaus upon which rise the Tonga Islands. They are the summits of a great ridge over 200 miles in length, sloping very gradually to the westward and being somewhat more steep to the eastward, into deeper water, towards the smaller platforms from which rise the volcanic peaks of the group. The plateaus of Tonga-Tabu, Namuka, Hapai, and Vavau, being separated by deep valleys connecting the eastern and western flanks of the ridge. These four plateaus rise abruptly from the 100-fathom line. The extremity of the southern one is occupied by Tonga-Tabu Island. The land behind the cliffs of its southern coast rises to a height of over 250 feet and slopes northward very gradually to form the low land which occupies the north coast of the island, and is, except, at Mount Zion and Cook Hill, not more than from 10 to 20 feet above the level of the sea. At Cook Point (and along the southern coast) three terraces are indicated. The northern coast is deeply indented by shallow bays, full of islands, reef flats, and reef patches, on which corals grow in great profusion. In a distance of nearly 10 miles northward of Nuku-Alofa the plateau is nowhere more than 15 fathoms deep; and a long tongue runs northward, gradually deepening into 20 to 50 fathoms to the 100-fathom line.

The Tonga-Tabu plateau is separated from the Namuka group plateau by a funnel-shaped channel with a depth passing rapidly into 300 fathoms from the 100-fathom line. The Namuka plateau is rectangular. The principal island is Namuka, where we anchored. We found the island to be composed of tertiary elevated coralliferous limestone with a shallow sink, filled with brackish, occupying the southeastern part of the island. The sink is separated by a high sand beach, about 200 yards wide, from the sea.

Namuka Iki, the island next to Namuka, we found to consist, at its southern extremity, of stratified volcanic material resembling somewhat the so-called soapstone of Fiji. I was told that other islands in this group, near Tonumeia, in the center of the Namuka plateau, were volcanic. Mango, as we could see it from our anchorage, appeared to be volcanic. So that this part of the Tongas is, like the Lau Group in Fiji, made up of islands in part volcanic and in part composed of elevated coralliferous limestone. The eastern edge of the Namuka plateau (which we did not visit) is edged with small low islands. We merely steamed past the western islands of the Hapai Group, but close enough to see that Tongua, Kota, and Fotuhaa, which are respectively 120, 120, and 200 feet high, are composed of elevated limestone. The eastern flank of the Hapai plateau is edged with long low islands with extensive coral reefs along the reef flats of these islands.

The Hapai plateau is triangular, with isolated islands rising on the northwestern side from the deep water separating it from the Vavau plateau. It is separated from the Namuka plateau by a narrow channel with over 300 fathoms of water.

The northernmost plateau of the broad ridge of the Tonga Islands is the Vavau plateau. This is elliptical, with a long tongue extending on the eastern face of the ridge toward the northern point of the Hapai plateau, ending in isolated banks (the Disney and Falcon banks), lying to the northward of the broad channel, with over 400 fathoms separating it from the Hapai group. The Vavau group is by far the most picturesque of the Tonga Islands. It consists of the principal island of Vavau, extending across the northern part of the Vavau plateau. Several parts of the island of Vavau are finely terraced; four terraces are indicated there, and other flat-topped smaller islands

show traces of two or three terraces. The northern edge rises to a height of more than 500 feet, and slopes in a general way southward and inland. The southern shore is deeply indented by bays and sounds and flanked by innumerable islands and islets, some of considerable height (150 to 250 feet), which gradually become smaller and smaller as they rise toward the southward and eastward, these islands having been formed from the denudation and erosion of the greater Vavau. They form tongues of land and sea and sounds of all shapes and sizes, showing the traces of the former land connections of the islands and islets and their disintegration on the eastward and southward by the action of the sea. The islands and islets to the southward of the main islands rise from more or less extensive reef flats which stud the whole plateau, and on which corals grow in great profusion (mainly Millepora, Porites, Pavonia, Pocillopora, Fungia, and Astrea) to a depth of 5 to 6 fathoms in the sound. In the Namuka group they extended in the more open waters to 14 and 16 fathoms.

It is evident that in the Tonga group, which is a very extensive area of elevation, the recent corals have played no part in the formation of the masses of land and of the plateaus of the Tonga Ridge, and that here again, as in the Society Islands and Cook Islands, both also in areas of elevation, they are a mere thin living shell or crust growing at their characteristic depths upon platforms which in the one case are volcanic, in the other calcareous, the formation of which has been independent of their growth.

We expect to leave for the Ellice, Gilbert, and Marshall Islands as soon as we can coal and refit.

A. AGASSIZ.

THE PROBLEM OF HONEYCOMB.

To the Editor of the SCIENTIFIC AMERICAN:

I WAS amused at the theory of the structure of honeycomb, in SUPPLEMENT, February 3, No. 1257. Honeycomb is not formed by melted wax cooling and crystallizing, nor is the wax after its formation ever melted until the housewife melts it for market, to be experimented with by Messrs. Dawson and Woodhead.

The cause of the hexagonal arrangement of the cells of honeycomb is simple, a number of cylinders of any plastic material set up together and compressed so as to occupy the entire space, will assume the hexagonal form. A number of bees, on end crowded together, will be in the same condition, each one surrounded and in contact with six others, all trying to build a circular cell, and each one opposed by his six neighbors with a force equal to and in opposition to his own, results in a straight wall between them, or, if he lays his course of plaster while his neighbor is out, he no sooner leaves than the neighbor returns with his hod, and finding the circular rim encroaching on his cell, proceeds to push it back and lay his course; these alternate straightenings result in a straight wall, as if they worked at some time against each other.

The cells of the wasp nest are arranged in the same form, but if examined closely the first cluster, built by the mother wasp before her children commenced working with her, are round. The outside row of cells are also round on the outside. The outside row on the edge of sheets of honeycomb are also round or circular on the outside. I suppose, without trying the experiment, the appearance of Messrs. D. and W.'s wax was caused by bubbles on the surface of the melted wax settling as they cooled. "Quod erat demonstrandum."

Selma, Ala. W. E. BOYD.

The editor referred the above to the United States Department of Agriculture and we give herewith the answer received:

United States Department of Agriculture,
Division of Entomology,
Washington, D. C.

February 23, 1900.

To the Editor of the SCIENTIFIC AMERICAN:

Dear Sir: Your letter of February 20, inclosing a communication from Mr. W. E. Boyd, of Selma, Ala., in reference to the shape of the cells built by honey-bees, has been received and referred to the apiarian expert of this division, Mr. Frank Benton, who reports as follows:

"The theory brought forward by Mr. W. E. Boyd that the cause of the hexagonal form of the cells made by honey-bees is due to mutual lateral pressure, is that generally accepted at present by expert and scientific authorities who have investigated the matter. It is by no means a recent theory, having been mentioned by Buffon some 140 years ago and seriously discussed at least as early as 1858 by members of the Entomological Society of London (see Trans. Ent. Soc. of London, 1858, published in 1859, p. 84; also Rept. Brit. Association, pp. 132–133), and having again received considerable attention in Germany some twenty years since (see Muellenhoff, On the Formation of Honeycomb; Pflueger's Archiv. f. gesammt. Physiologie, xxxii., pp. 589–618, 1883; and Structure of the Honey-bees Cell, Archiv. f. Anat. u. Physiol., pp. 371–375, 1886).

"It is also true, as Mr. Boyd says, that the wax after it is formed is not melted before being fashioned into comb. The eight wax pockets or molds are situated on the concealed surface of the ventral plates, between the first and sixth abdominal segments of the insect. The wax as secreted by the glands directly underneath these molds, oozes in a liquid state through the membrane and, hardening in the mold, is plucked out in minute scales and passed forward to the jaws of the bee to be fashioned into comb cells. While at a temperature of 80° to 100° F. beeswax is quite plastic, it does not become liquid until about 160° F. is reached. When bees are building comb a temperature of from 90° to 100° F. is as far as has been observed, maintained in the cluster, and a temperature of 110° to 115° F. causes them to suspend comb building and resort to extreme exertions to decrease the heat by fanning. Thus the possibility that the wax is in a liquid state when the molding into hexagonal cells takes place, is precluded. Whether the formation of wax crystals might not, under certain conditions, take place at temperatures between 90° and 110° F., and whether these crystals would be of the size and shape of natural cells made by bees and thus furnish the guides for them to build upon, must still be a matter of experiment. No such observations have been recorded. It is, however, well known that all cells built by honey-bees are round at first, and only become hexagonal when surrounded by other cells. There are also two distinct sizes of hexagonal cells. I have myself noticed hexagonal figures formed in wax when cooling from the liquid state, but, knowing well that numerous air-bubbles in contact with each other result in approximately hexagonal forms, I have never attributed these figures to any inherent property of the wax itself."

Mr. Boyd's letter is returned herewith.

Yours very truly,

L. O. HOWARD, Entomologist.

THE INCREASING PRODUCTIVENESS OF LABOR, A RESULT OF INVENTION.*

By FRANCIS H. RICHARDS.

IN former times industrial advancement was a matter of degree; some builded better than others, but all worked by the same general methods and employed substantially the same means. Now the car of progress runs in new channels. The agencies by means of which advancement is now effected are largely new in kind; invention has come to the rescue of the laborer.

Resources and privileges formerly undreamed of by the laboring classes have become a common inheritance. For instance, from being an exceptional event—a thing permitted to the few—travel has become common. The railroad and the steamship have given people of every race and degree a broader acquaintance with each other, with the natural result of increasing friendship among individuals, communities and nations.

Education, in a broad and true sense, has become equally general, giving the power of advancement to those formerly held in the bondage of ignorance and incapacity. Under such influences competition is becoming less and less a mere struggle for existence, but rather an emulation in the achievement of useful results. A long step has been taken toward the final accomplishment of that ancient command, "Inherit the earth and subdue it." All mankind are naturally qualified in some measure for the gradual development of their faculties and abilities, for that promotion, step by step, from one vocation to another, which has become not merely a privilege but a positive necessity. It is no longer possible, in progressive nations, for the laborer to maintain a status quo.

Education properly includes both learning and training, all experience whereby one's powers are extended and disciplined; it continues through life and is not restricted to the period of youth. It has become the duty of every one to learn something more every day. This, perhaps, suggests the true reason for the decadence of the apprentice system—a change which, after all, may be merely the extension of a truer apprenticeship to the whole duration of one's working years.

Not so very long ago all labor was classified as skilled or unskilled. Above the skilled labor zone, on the one side, were the professions, with an impassable gulf between; while below were the peasantry classes, untrained and non-progressive. All this has changed; the wide chasm has been bridged. The laborer, possessing both skill and training, now exercises professional powers; he stands shoulder to shoulder with—in every just sense the equal of—the professional man and the scholar. Professions and trades, handicrafts and vocations, have been multiplied and a new classification of the laborers is necessary. Can we not fairly designate them "professional," "expert," "trained," "untrained?"

The march of invention constantly draws the more skillful classes of workers into new fields, and thereby furnishes the opportunity through which the less skillful classes can advance into higher occupations. A new industry necessarily draws operatives from the old and naturally attracts them, first, from the more intelligent and progressive class of workers. The void thus created is filled by the promotion of those who from want of intelligence, experience or discipline were not available for the new requirements. This process once started must continue down through every grade and class, until all share in the general advancement and until, finally, the idle races of the world—even the barbarian and the savage—shall become enlisted in the industrial armies of civilization.

The practical benefits already resulting from these influences are clearly stated in a recent Connecticut paper, quoting from The Engineering Magazine, in an article from which I make a brief extract:

"Luxuries as well as necessities have been multiplied by invention. By the aid of improved machinery, that which at the beginning of the century was the luxury of the rich is now the comfort of the poor. Assisted by machinery and tools, man's labor now converts the raw materials of nature into the useful, necessary and even in some cases the artistic paraphernalia of civilization with one-third of the exertion formerly necessary.

"Few realize how much we are indebted to the inventor and machine designer for the comforts, luxuries and necessities of our daily life; the loom which weaves our silks, cottons and woolens; the harvesting machine which reaps our corn; the machinery which forms our bricks and mixes our mortar; the printing machine which makes the penny newspaper possible. Our food, clothing, furniture, literature, all are produced on machinery, which it is practically impossible to make or maintain without the modern machine tool."

At no time in history has industrial progress been so rapid or general as since the close of the American Civil War. During this period of only thirty-five years a revolution has taken place greater in extent and more far-reaching in its beneficial effects than was ever accomplished by wars or conquests. Industry and commerce, supplied by invention with new resources, have advanced at a rate hitherto impossible; their forces have grown from mere squads to battalions and armies, in which great numbers of workers of many classes and capacities have been brought from a condition of uncertain employment and destructive competition to an economical and effective co-operation.

Not only has skilled labor become more productive, but unskilled labor has been made more available, through improved machinery and better administrative methods in carrying on manufactures of nearly every kind. This, indeed, is one of the signal triumphs of this century—the effective utilization of that vast resource which in earlier times went to waste, the energy of the unskilled masses.

Invention, by the creation of new instrumentalities, has opened the door of opportunity; has brought to the homes of the artisan and the peasant advantages formerly beyond the reach of prince or potentate.

If capital is merely the accumulated product of labor, then education and skill are among the highest forms of capital, for they are acquired at the cost of much labor. And, also, the immense fund of inventions already accumulated is a principal item—if not the principal one—of the vast capital now employed in the service of mankind.

LABOR IN THE COTTON INDUSTRY.

The secretary of one of the most progressive New England manufacturing companies, George Otis Draper, says, with relation to the efficiency of labor in the cotton industry:

"In spinning the product of the machines has practically doubled in the last thirty years, and the capacity of the operative has not only doubled with the machine, but has trebled or even quadrupled. The improvement has been of such a nature that the increase in speed has been attended with benefit to the product. In weaving the product per operative has easily trebled: it is certain the product per operative in other departments of a cotton mill has at least doubled.

"Formerly a weaver tended but one loom, and that at a moderate speed. To-day weavers on the Northrop looms often tend twenty-four machines running at a speed nearly double that of the original power looms. In some lines a weaver still tends only one or two looms. In 1895, when the Northrop loom was first introduced, the maximum of an operative on common looms was represented by eight."

LABOR IN PRINTING.

In the printing art the progress made is equally remarkable and extends to every department of the business. The telegraph and telephone bring the news with lightning speed from every quarter of the globe; complex mechanism reduce it to "composition" and turn out the forms for "perfecting" presses, which run off immense editions of newspapers that are quickly distributed by railroads and pneumatic tubes throughout the cities and villages of the land.

During the last decade of this century the type composing machine has finally reached commercial success. Of the leading machine, and the results of its introduction, Philip T. Dodge, Esq., president of the Mergenthaler Linotype Company, of New York, writes thus:

"With reference to linotype machines about five thousand are in use in America. The machine is wholly automatic in its operations, being controlled by a single operator at the keyboard, and produces ordinarily as much composition as four or five hand compositors, while some operators produce steadily as much matter as six good hand compositors.

"The cost of machine composition varies under different conditions from 25 to 65 per cent. of the cost of hand composition. A net saving of 50 per cent. in the cost of composition is very common.

"The result of the cheapened composition has been a vast increase in the quantity of printing done, with a corresponding increase in the number of men employed, in the demand for presses, paper, ink and other articles entering into the printing business.

"So far as the workmen are concerned, the introduction of the machine has been beneficial. There are as many compositors employed to-day as there were before the introduction of the machine. The average hours of labor have been lessened from 10 to 20 per cent., and the wages paid for these shorter hours are from 10 to 35 per cent. greater than they were in the days of hand composition. In other words, the effect of the machine has been to cheapen and increase the amount of printing, to give employment to a greatly increased number of men, and to shorten the hours and increase the wages of the compositors."

THE EFFECT OF MODERN EXPLOSIVES.

A well-known engineer and manufacturer of Scranton, Pa., Col. H. M. Boise, president of the Moosic Powder Company, furnishes this statement:

"The consumption of powder in mining has increased during the past twenty-five years at even a greater ratio than mining itself. Many public works already accomplished would have been commercially impracticable except by the use of powder of a greater power and the ability of manufacturers to furnish it at a less cost. The cost of such grades of powder as are employed, for instance, in coal mining has been very largely reduced. One grade of mining powder sold in 1865 for $6 a keg; in 1875 it had fallen to less than $4, and at present it is furnished for $1.25 a keg, and sometimes even less. Within the past twenty-five years what are known as 'high-grade explosives,' composed of nitroglycerin and other compositions, have been made by Nobel and others commercially practicable, and have so reduced the time required for great engineering works as to render many of these later projects commercially possible. Otherwise the public must have waited for generations before they could afford such improvements, for instance, as the Croton Aqueduct and the Chicago Drainage Canal. Owing to their great cost no one would have dared undertake such projects under the conditions that formerly existed."

PROGRESS IN ENVELOPE MANUFACTURE.

One of the best known envelope manufacturers, William H. Prescott, of Rockville, Conn., for more than a quarter of a century at the head of the envelope works of White, Corbin & Company, furnishes an account of the gradual development of the envelope business, from which I make this extract:

"The use of envelopes was very limited previous to 1855. About this time Milton G. Puffer, of Vernon, Conn., patented a machine performing the work of five girls, as compared with hand labor. This invention was considered a great curiosity and for a few years was very profitable.

"About 1862 George H. Reay, of New York, made an improvement which gradually superseded the Puffer machine and performed the work of about seven girls.

"Later, about 1866, the Berlin & Jones machine was brought out in New York. It had a device for putting the gum on the sealing flap, did the work neater and better, and performed the work of about ten girls.

* President's address at the Annual Meeting of the American Association of Inventors and Manufacturers, Washington, D. C., January 16, 1900.

"A few years later this machine was largely superseded by the Leader machine, brought out by Lester & Wasley, of Norwich, Conn. This machine performed the work of about twenty girls, and is one of the principal machines in use at the present day, although most of the patents thereon have now expired.

"The next envelope machine of note was the Richards invention, which gummed, printed, folded and counted the envelopes, delivering these upon a table in completed bunches of twenty-five envelopes, with a band around the bunch. These machines perform the labor of about thirty girls, and are running in the factory of the United States Envelope Company (White, Corbin & Company department) at the present time.

"The consumption of envelopes in the United States amounted in the year 1899 to about 6,000,000,000. The cost of a commercial envelope sold to the jobbing trade in 1860 was $3.40 per 1,000. The same grade—but really a better article and put up in a more attractive manner—is sold to-day for seventy-one cents per 1,000."

THE TWIST DRILL.

A prominent Ohio manufacturer, J. D. Cox, Jr., of the Cleveland Twist Drill Company, manufacturers of twist drills, reamers, milling cutters and other tools of precision, states that:

"Beginning in 1876, the firm with whom I was connected found that with the appliances then used they could make only a very moderate profit. The writer took up the question of improved appliances, as you know, about the year 1880, introducing machines in every department—some of your invention and some of the writer's—the sole object being to reduce the amount of labor and not considering the cost of the machines. The selling price of our class of goods has been reduced more than 60 per cent. during the past 20 years, all of which I can say without hesitation has been accomplished by the introduction of labor-saving machines and appliances."

These reports come from gentlemen of wide experience in their respective lines of business. With one exception they are members of this association and all have given attention to the questions involved in this subject. We can, therefore, safely accept their conclusions as being reliable. Their testimony is, in fact, conclusive.

Since the close of our Civil War the productiveness of trained labor in the United States has increased threefold, and this has been accomplished principally by the work of American inventors, encouraged and supported by the American patent system.

SANTA ANA CANAL.*

By J. B. LIPPINCOTT.

GENERAL STATEMENT.

THE area discussed in this report is in Southern California, lying for the most part easterly from the city of San Bernardino and consisting of the upper or higher part of the valley in which is situated the town of Redlands. It is about 50 miles distant from the ocean and has an elevation of from 1,000 to 1,500 feet in the vicinity of San Bernardino and Redlands. Northerly and easterly from the valley the mountains rise abruptly, reaching altitudes of from 6,000 to 7,000 feet, a few of the peaks rising to 10,000 or even 11,000 feet. The abrupt slopes by which the valley is bounded aid in producing a rainfall relatively heavy for the arid region. The waters, uniting into streams, descend rapidly through narrow gorges, issuing finally upon accumulations of bowlders and smaller débris which stretch in fan-shaped masses away from the mouth of each canyon. The region, though dry, has thus a notable water supply, and the exceptional climate and soil have resulted in an extraordinary development of agriculture by irrigation. Lands and crops have reached high values in San Bernardino Valley and expensive irrigation works have been built. A denser population is supported than in any other farming region of the West. This has been accomplished in spite of the fact that the cost of constructing works and of reclaiming the lands has been very great.

The topographic conditions of this locality favor the production of high-grade fruits. The ranges of mountains to the north and east shut out the cold desert winds, leaving the southwestern exposure tempered by breezes from the sea. The distance inland is sufficient to admit of the high summer temperatures necessary to the successful ripening of citrus fruits. The success of this industry has rendered it possible to secure capital for the construction of the works for water storage and distribution, and has resulted in a correspondingly great economy in the quantity of water employed. In this valley water is made to do more work and earn greater returns, probably, than in any other portion of the arid region of the United States.

The discussion of the water resources given in the following pages relates particularly to the systems taking water from Santa Ana River and its tributaries and supplying Crafton, Highlands, Redlands, and Old San Bernardino. There has also been included a discussion of Mohave River, which rises on the northern slopes of the mountains and flows northerly into the desert, for it is probable that by means of certain storage works now under construction much of this water will be caught and turned southward by diverting lines or tunnels to supply portions of San Bernardino Valley.

The Santa Ana Canal was designed to carry the waters of Santa Ana River and its main tributary, Bear Creek, as well as the waters turned into the latter stream from the Bear Valley reservoir in times of scarcity, to the lands of the Perris and Alessandro districts, some 15 miles from the headworks of the canal. When this work was started a line of steel pipe of a capacity of 900 miner's inches had already been constructed from Alessandro to Mill Creek, 9·7 miles of the distance.

The capacity of this canal was fixed at 12,000 miner's inches (240 second-feet), but the main portions of the conduit were constructed for a capacity of only one-half of this, or 120 second-feet, with the idea of afterward enlarging it. It was not supposed that Santa Ana River and its tributaries would furnish a constant supply of 12,000 miner's inches, but it was intended that the conduit would serve to carry the surplus waters of the rainy season to suitable reservoirs, where the water could be stored and distributed to users when needed in the summer and fall months. Bear Creek has a large reservoir near its head waters—the Bear Valley reservoir, with a present capacity of 26,463 acre-feet, or 3,675 miner's inches, not including evaporation.

Santa Ana River proper has no storage reservoir, and as it has 188 square miles of drainage basin above the head of the Santa Ana Canal there is necessarily a great deal of water that runs to waste nearly every year during the winter and spring months. It is proper to mention in this connection that a small reservoir site was surveyed and work commenced on the outlet tunnel for the purpose of storing the water of Santa Ana River, but on account of the financial embarrassment of the company this work was never finished. In fact all construction work was stopped, and the Santa Ana Canal was turned into a temporary conduit to conduct 900 miner's inches of water from the river to the Alessandro pipe line.

This reservoir would necessarily have been a regulating one, as it had a very small capacity for a very high and expensive dam. In other words, it would never have paid as a simple storage reservoir, but in case Santa Ana River and Bear Creek were flowing for a few days more than the Santa Ana Canal could carry some of the surplus water could have been held in this reservoir until the discharge of the stream had fallen below the capacity of the canal, and in this way the reservoir might have been filled and emptied several times during the year.

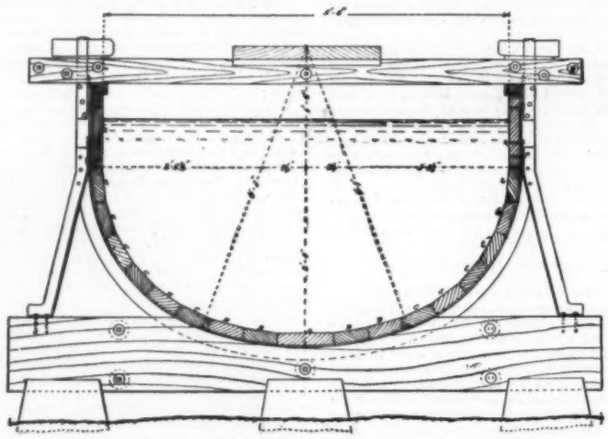


FIG. 3.—SECTION OF COMBINATION IRON AND WOOD FLUME.

The Santa Ana Canal, which has been completed for only about 6 miles, offers some valuable lessons to the engineer, not only by the excellence of the work done in some places, but by its weak points in others.

FIRST DIVISION.

The first division of the Santa Ana Canal for about 3 miles consists of tunnels, flumes, and pressure pipes, being located on the rocky, steep side of Santa Ana Canyon. The design for the permanent headworks of of the canal provides for a low crib weir, or overflow dam, crossing the canyon from wall to wall and built upon the natural bowlder of the stream. A sluice gate is to be constructed on the left bank that will maintain the channel of the river on that side of the canyon and which when closed will raise the water to such an elevation as to command entrance through the gates shown on the right hand side of Fig. 1, into a fore bay, and thence through the headworks tunnel cut through the rock to the canal. Regulation will be accomplished by means of entrance gates, shown on the right of Fig. 1. At present, diversion of water is made by means of a bowlder dam and wooden gate into a rock-lined canal leading to the headworks tunnel, the gates on the right now acting as regulators.

The river falls rapidly through the canyon; and as the canal does not have in any place a greater grade than 10 feet per mile, it results that at the place where the canal leaves the canyon it has an elevation of 300

FIG. 1.—TEMPORARY HEADWORKS.

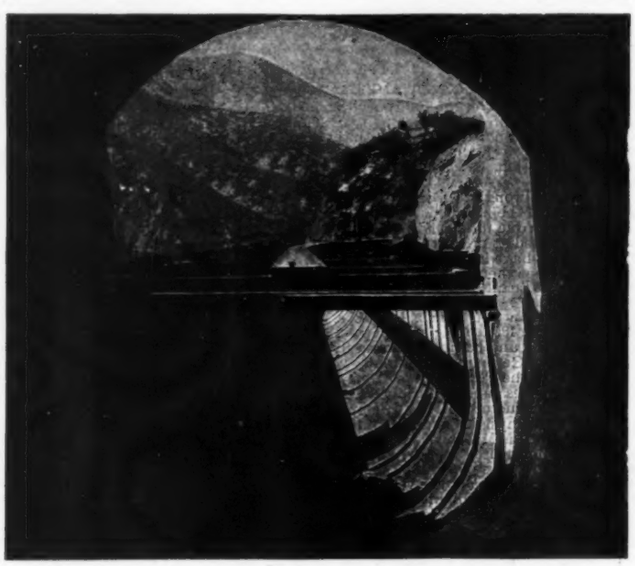


FIG. 2.—CONNECTION BETWEEN TUNNEL AND FLUME.

SANTA ANA CANAL, CALIFORNIA.

* Extract from the Nineteenth Annual Report of the United States Geological Survey; republished by permission.

feet above the water of the river. It then crosses Deep Creek with a wooden pressure pipe, as shown in Fig. 2; thence through a long tunnel to Morton Creek, with similar pressure pipe, and thence through a short tunnel to the mesa lands between Santa Ana River and Mill Creek, where the section is changed to a masonry-lined canal. This, with the exception of a few short flumes and the Mill Creek crossing, is the form maintained for the remainder of the conduit.

FLUME.

The first and most noticeable feature in the canyon tion of the flume a very interesting point was raised. In order to counteract the piling up of the water from the centrifugal force due to the velocity of the water rounding the curves, the outer concrete footing was elevated and the inner one depressed in proportion to the degree of the curve. The result was that, as the staves were rigid and could not well be twisted, the abutting joints could no longer be cut in vertical planes, and every stave had to be cut and fitted by hand. If these concrete fittings had been level across, and the joints consequently in vertical planes, a miter machine would have saved considerable labor in the cutting of the old style, square, wooden flume, and it has some weaknesses, which time and adverse conditions have brought out very clearly. The greatest advantage that can be claimed for it is that there is not a single nail in the flume proper from end to end. Again, it can be tightened by screwing up the nuts on the rods which pass around the staves and through the wooden yoke on the top. It is a good shape, giving a large hydraulic mean radius. It has comparatively few places where the wooden surfaces come in contact with each other, thus adding much to its life.

FIG. 4.—SANTA ANA CANAL ON THE MENTONE BENCHES, CALIFORNIA, SHOWING FLUME SUPPORTED ON A TRESTLE.

is the flume. It is made of 1¾-inch redwood staves, about 6 inches wide, is of circular form on the bottom, and has vertical sides about 12 inches deep at its 120-second foot capacity. It is 5½ feet wide in the clear on the top, and about 3 feet 3 inches deep in the center. A good view of this flume can be had in Fig. 2, taken from a photograph showing also the inside of a lined tunnel.

The flume is supported every 8 feet by a T iron, bent to the shape of the outside of the flume, and held from spreading by a wooden yoke on top. This T iron rests on a wooden sill cut to fit it, and this sill in turn rests on three concrete footings molded on the solid rock of the flume bench, and when softer material on the bench is encountered, on suitable midsills of California redwood, which has valuable lasting qualities in contact with earth. The staves are also held in place by staves. Such a machine was constructed, but could not be used.

The curved part of the flume, as shown in the cross-section, Fig. 3, was made in the shape of a three-centered arch, apparently with the idea of giving it a broader base. It would, however, have been very much simpler in cutting and fitting the staves if all of the parts had been of one circle instead of two.

The flume could have been reduced in width from 5 feet 6 inches to 5 feet 2 inches and had a semicircular bottom without practically increasing the amount of lumber or greatly lessening its hydraulic mean radius. The area of the full cross-section as built is 15·5 feet, and when filled within 3 inches of the top of the sides the idea of cross-section of the water is 14·1 square feet, the wetted perimeter is 9·5 feet, and the hydraulic mean radius 1·48 feet. A semicircular flume filled with-

Its weaknesses may be enumerated as follows: It has a great many longitudinal joints, thus increasing the liability to leakage. Its butt joints, for every 8 feet on curves, are all in the same vertical plane, or nearly so, thus rendering it weak in the case of a slide coming against it from the inside of the curve. The method of tightening at the T irons, as shown in Fig. 3, by straps and wedges passing above plates resting on the yoke, is not so effective as that of using simple nuts and threaded bolts as in the intermediate binders. Loss results from the great expansion and contraction that takes place in what is practically a surface of about 10 feet wide with 18 joints, when the flume is alternately wet and dry, and from care and attention needed to keep it tight.

The unusual shape of the lumber used in its construction is objectionable, every stave having a bead about ⅛ of an inch in diameter running along the side where it joins the next one. In case of extensive repairs it is necessary to have a great deal of this lumber in stock or else have it manufactured by especial order. An examination of the flume at present reveals a great number of leaks in the longitudinal joints, on the canal division, where there are several canyons crossed by flumes supported on the trestle work. These leaks are caused by turning water which bears sand and fine gravel into the flume after it has been empty for several days without first cinching up all the binders.

Four to five days in the sunny climate of Southern California is sufficient to thoroughly dry the staves and cause so much contraction of the wood as to open the joints and practically sever the connection of the staves at the bottom of the flume with those on the side, which are their natural support when the binders are tight. The consequence is that when the water is turned into the dry flume the staves in the bottom, which are only 1⅞ inches thick in the direction of the weight, are deflected in the middle of the 8-foot lengths, the ends of which rest on the T irons, and the water rushes through the joint, carrying sand and small gravel with it. This is caught in the opening by the little bead, and there it remains, thus keeping the joint open and preventing the flume from being made tight again by cinching, unless it is taken apart and all of the sand and gravel removed. This would be a tedious and inconvenient operation, necessitating the recalking and asphalting of the vertical joints.

The bending of the lower staves gives the appearance of weakness to the flume, and leaking has attributed to this cause by some who have not understood the design of the intermediate binders. When these are kept tight the weight of the water in the 8-foot joints is carried by the vertical side of the flume, but when these are allowed to get slack the strength of the flume as a girder is destroyed, and leakage and distorted, bent, and broken staves are the result. The financial affairs of the Bear Valley Company have been in such a condition since the flume was built that it has had very little attention. It seldom, if ever, has had more than 1,000 miner's inches of water running in it, and it is safe to say that fully 15 per cent. of the water turned in at the headworks never reaches the lower end of the canal, where the connection is made with the Alessandro pipe line.

There is difficulty in making a tight joint where the

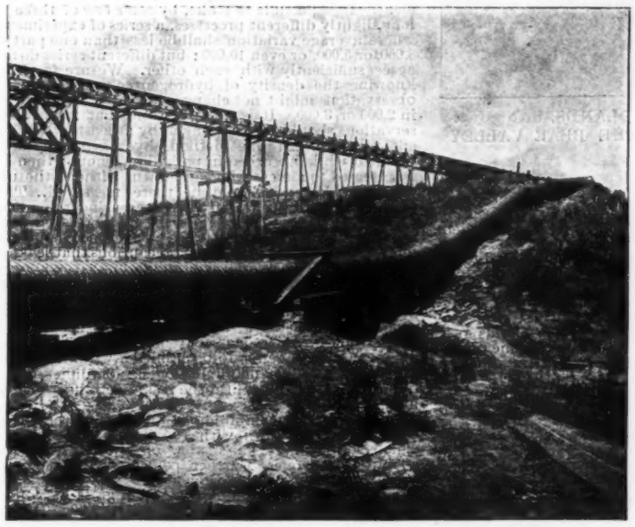


FIG. 5.—OLD FLUME AND NEW STAVE PIPE REPLACING IT, REDLANDS CANAL.

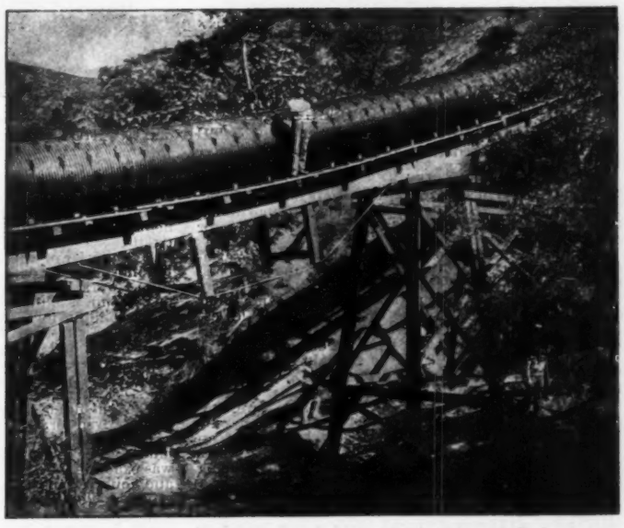


FIG. 6.—PIPE UNDER 160-FOOT HEAD, SANTA ANA CANAL.

VIEWS OF REDWOOD-STAVE PIPES IN CALIFORNIA.

⅝-inch iron rods, two between each two T irons, so as to bring the weight of the water and the curved part of the flume itself between the footings of the vertical sides. These rods are bent to the shape of the flume and pass through wooden crosspieces on top. On tangents the staves are 16 feet long, and on curves 8 feet, the minimum radius being 65 feet, the staves in all cases abutting on the center of the T-iron frames.

This is a fairly good arrangement on tangents, but the greater portion of the flume had to be built on very sharp curves to save tunneling and heavy excavation, and on curves it is not so good. During the construc-

in 3 inches of the top would have a cross-sectional area of water of 14·2 feet, a wetted perimeter of 9·57 feet, and the same hydraulic mean radius, the height of the flume being 3 feet 7 inches instead of 3 feet 3 inches. This latter would have been a better shape for tightening, as it is evident that the flatter the curve at the bottom the more difficult it is to make the joints tight. It would also have simplified the stave cutting and handling, and the flume could have been made just as firm on its foundations as the present one, with a slight saving of lumber in the yokes and sills.

This flume has many advantages over the ordinary, butts come together over the T-iron frames without interfering seriously with the flow of water in the flume. As arranged at present, these joints are calked with oakum and plastered over with asphalt. This work was carefully and well done, taking everything into consideration, but it is impossible to make this kind of a joint without leaving a little ridge of asphalt clear around the flume at every joint. This might not at first sight appear to affect the flow of water very much, but it apparently does lessen the amount which the flume was calculated to carry 36 per cent. on an average for depths not exceeding 15 inches.

The following measurements of actual velocity have been made carefully by meter, and the calculated amounts are placed beside them to show the difference in each case:

COMPARISONS OF CALCULATED AND ACTUAL CAPACITIES OF SANTA ANA CANAL FLUME.

Depth at center.	Area.	Wetted perimeter.	Hydraulic radius (area divided by perimeter.)	Velocity per second.	Calculated capacity.	Actual capacity.
Inches.	Square feet.	Linear feet.	Feet.	Feet.	Second-feet.	Second-feet.
13¼	4·26	5·75	0·45	5·45	23·25	12·19
12¼	3·43	5·33	0·65	5·20	17·83	13·31
10¼	2·75	4·91	0·56	4·60	12·65	9·78
12½	3·63	5·38	0·67	5·25	19·06	9·66
10¼	2·75	4·91	0·56	4·60	12·65	9·57
14⅝	.....	.....	.....	3·37	23·76	15·00

The value of n in Kutter's formula was assumed as 0·01, being a fair assumption for planed lumber, but the above measurements show that all the conditions were not taken into account, because from the actual velocity the value of n would be nearer 0·015.

This is mentioned simply as an example of the difficulty in making practice agree with theory for even the most careful engineers. Great care was taken with the meter measurements.

WOODEN PRESSURE PIPE.

The next feature of this work that attract the engineer's attention are the pressure pipes, of which there are three, all 52 inches inside diameter and made of redwood staves bound with ⅝-inch steel rods, with special castings of malleable iron, into which the rods are connected and tightened by nuts and screws on their ends. The distance between the binding rods is proportioned to the pressure that the pipe has to bear, with a factor of safety of 4.

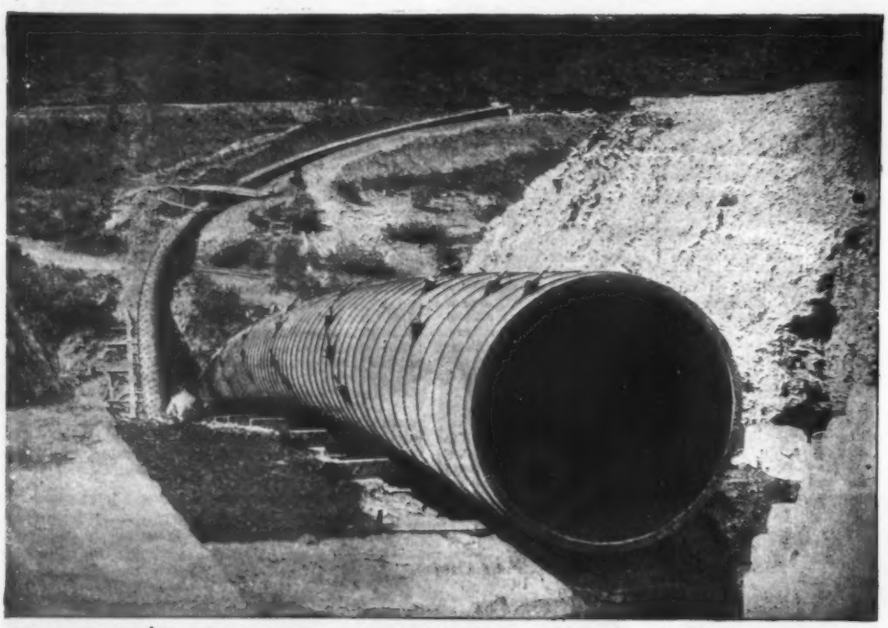


FIG. 7.—REDWOOD PIPE CROSSING WARMSPRINGS CANYON NEAR REDLANDS, SAN BERNARDINO COUNTY, CALIFORNIA, ON THE MAIN HIGH LINE OF THE BEAR VALLEY CANAL. The diameter of the pipe is 52 inches.

The first of these pipes is at the crossing of Warmsprings Canyon. It is 540 feet long and under a pressure of about 25 pounds to the square inch in its lowest part. The Deep Creek pipe is 908 feet long, and under a pressure of 67 pounds to the square inch in its lowest part. The Morton Creek pipe is 680 feet long, and has the same pressure as that at Deep Creek.

These pipes are made of clear straight-grained redwood staves about 6 inches wide, varying from 2 to 3½ inches in thickness, and of various lengths, as the butts are intended to break joint. The butts ends are connected with an iron dowel about ½ by 1½ inches by the width of the stave, let into saw kerfs ¾ of an inch deep, in the ends of the butting pieces. This makes a very effective and tight joint, there being absolutely no leaks from the butt joints on any of the pipes of this work. The pipe is partly cinched up, and the staves are then driven tightly home, longitudinally, with a 12-pound maul, each stave being so driven.

In the first wooden-stave pipes made on the Pacific Coast wooden dowels were used, but it was found that the swelling of the dowell as soon as water was turned into the pipes split the redwood and caused many leaks. Later methods of cinching have largely obviated this defect.

The longitudinal joints are made tight by a bead about ¼ of an inch in diameter being run along the center of one side on each stave, so that when the rods are cinched up the bead sinks into the adjoining stave, and thus makes a small tongue and groove connection and a very tight joint. The wood in these staves is very straight grained and smooth, being planed on all sides, and gives an ideal coefficient of roughness, so much so that a wooden pipe of this class can always be of much less diameter than a metal or cement pipe carrying the same amount of water.

An interesting point about these pipes is that, unlike tanks or other vessels bound with iron or steel hoops, they can and should be tightened up as much as possible before allowing the water to be turned into them. The swelling of the wood which then takes place has only the effect of sinking the round steel rod into the surface of the redwood, while it would assuredly break a flat band or hoop of the same cross-sectional area as the rod. The reason is that, the surface of the flat band being so great, the crushing of the wood does not take place, and the band has to bear not only the pressure of the water, for which it is calculated, but the additional strain imposed upon it by the swelling of the wood, for which it is not calculated. How great this force is may readily be seen by the depth to which some of these pipes are indented by the steel rods. This point has been dwelt on because it is of great importance in connection with a question raised during the construction of these pipes.

The weak point of these pipes is that the diameter is so large and the staves so heavy that it is impossible to curve them sufficiently to rest on the ground all the way across deep canyons. It is necessary, therefore, to support them for varying distances on trestlework. This, if of iron or steel, would be very expensive, and being of wood is liable to be burned down at any time, for fires are of frequent occurrence in these canyons in summer. Under these circumstances the pipes can hardly be called permanent structures, and as the Deep Creek and Morton pipes cost from $10 to $12 per linear foot it is certain that steel pressure pipes laid under the ground would have been more permanent and much cheaper. A steel pipe of 54 inches diameter, under a pressure varying from 0 to 95 pounds per square inch, would need to be on an average of one-eighth of an inch in thickness to give it a factor of safety of 4. Such a pipe would only weigh about 75 pounds per linear foot and would not cost over 6 cents a pound delivered, or $4.50 per linear foot. Allowing $1.50 a foot for excavating and back filling, this pipe could certainly have been built for a little more than half the cost and would have been much more permanent than the wooden pipe combined with the wooden trestle.

The interior of the wooden pipe is smooth and true. It is not liable to deteriorate like the steel or iron pipe.

It is durable, is easily tapped, is capable of adjustment, and is altogether the nearest approach to an ideal conduit for water where, in the case of large pipes, the pressure does not exceed 40 pounds per square inch and the nature of the ground is such that curves of less than 350 feet radius will not be required.

The pipe shown in Fig. 5 was built on the Redlands Canal near the mouth of Santa Ana Canyon, to replace the flume which is also shown. It is considered an improved form of construction because of the much greater length of life of the pipe, the fact that it is a much better conduit and is cheaper. In 1898, this pipe was examined, after it had been in service for ten years, and found to be in a sound condition. It has had no repairs. This has become a very popular conduit in the West, where iron is expensive and wood is cheap.

Fig. 7 shows a 52-inch redwood stave pipe under a head of 160 feet. It will be noticed that the round iron bands which hold the pipe together and resist the bursting strain are only 3 inches apart. When the number of iron bands is so large, the weight of metal in the stave pipe becomes almost as great as that of an iron or steel pipe, and thus limits the economy of its use. Another serious fault in the stave pipe is that in a rough country it cannot be bent to a sufficiently sharp radius to fit the ground. The minimum radius with 52-inch pipe is 240 feet, and for this reason this pipe is much higher up in the air than it is desirable to have it. With careful use, by keeping the pipe always full of water to prevent rot, the stave pipe should far outlive the iron pipe. An improvement that has recently been adopted on a power plant on San Gabriel River makes the sharp turns in the pipe line by putting in elbows of riveted steel pipe. These are made of sufficient diameter to fit over the ends of the wood pipe and the intervening space is rammed with cement.

(To be continued.)

[Continued from SUPPLEMENT, No. 1260, page 20168.]

ARE FURTHER EXPERIMENTS NEEDED FOR DETERMINING THE ATOMIC WEIGHT OF OXYGEN?*

By EDWARD W. MORLEY.

WITHIN the limits of convenience, it is well to vary the amount of substance taken in analytical determinations. This has been a frequent practice in the finest investigations. But that this practice derives any support from the so-called "limit method" cannot be conceded.

This criticism, this attempt at a theory, then, removes no obstacles and reveals no threatening pitfalls. If we desire a firmer foundation for our system of atomic weights, we must simply enlarge the experimental basis of our knowledge.

If it is only by further experiment that we can make surer of the atomic weight of oxygen, we are to consider what kind of experiments is most desirable. It is chiefly for the sake of eliciting discussion on this point that the subject of this address has been chosen.

Our present value for the ratio between oxygen and hydrogen rests on one single chemical combination, and upon two processes for determination. The first is, the synthesis of water from its components. The second is, the determination of the densities of the gases and of their volumetric ratio. Let us consider these in order.

What synthetic experiments should be repeated? We are met by the fact that a complete synthesis, in which hydrogen and oxygen and water are all three weighed, can be made with errors only about one-fourth as large as the errors in any of the syntheses where only two substances are weighed out of the three concerned. Other things being equal, then, this process is by far the most promising. But so far it has been carried out adequately only by one experimenter. Conditions were varied somewhat, it is true, but by no means so much as they would be varied if the same person repeated the experiments after an interval of years; by no means so much as if others were to undertake such complete syntheses. Lately, Keiser has devised a process which varies in many particulars from that already executed; it is very desirable that he should make a series of experiments, after adequate study of sources of error and of means of avoiding them. It is also desirable that, if possible, the original process of complete synthesis should be repeated with the little modifications which time is sure to introduce. These two would be enough, as far as synthesis is concerned; unless, indeed, through the invention of another process by a third experimenter, we could have still more. Other syntheses of water than by a complete synthesis seem less likely to be of much service, except as a school of experimentation.

What further work is desirable on the ratio of densities and of combining volumes of hydrogen and oxygen? Three constants are involved: the density of oxygen, the density of hydrogen, and the volumetric ratio.

The density of oxygen is known with a probable error of about one part in 50,000. It is very probable that no number whatever of further determinations would change this value by one part in 10,000. No further work upon this density seems at present desirable, except that whoever determines the density of hydrogen cannot well fail to determine that of oxygen also.

The density of hydrogen demands further experiment. It is possible to make, by some one of three or four slightly different processes, a series of experiments whose average variation shall be less than one part in 3,000, or 5,000, or even 10,000; but different series do not agree sufficiently with each other. We are far from knowing the density of hydrogen so well that more observations might not change our value by one part in 2,000 or 3,000. It is very desirable that further observations should be undertaken by at least two different methods. In one method, hydrogen should be weighed while absorbed in palladium, should then be transferred to a measuring apparatus without the use of stop-cocks and should be there measured. This process should be repeated with measuring apparatus of varied volumes. In another method, hydrogen should be weighed after Regnault's method, in a counterpoised globe, but with such precautions that leakage through a stop-cock, and contamination with vapor of mercury, should be excluded. The globe should be exhausted till the remaining air is a small fraction of a millionth, should be sealed off from the pump, and should be connected with a condenser at the temperature of liquid air, so as to remove mercurial vapor. After this hydrogen is to be admitted without the use of stop-cocks. The manipulation is not difficult, and the method would confirm the results of the previous method.

The ratio of the combining volumes of hydrogen and oxygen is not known with the degree of confidence which is desirable. The history of the matter is not an interesting one. Further continuance of the two series of experiments on which the present value depends would be most unlikely to change it by 1 part in 10,000, for its probable error is 1 part in 40,000. But one of the experimenters has obtained results differing from that finally adopted by as much as 1 part in 220. The other experimenter has entirely discarded the result of one series and replaced it, not by a better series of the same kind but by one of a quite different nature, not carried to its proper completion, and accordingly reduced by the use of the constants of Van der Waals' equation. It is desirable that experiments be made to furnish means for a new reduction by measuring the change of volume when 2 volumes of hydrogen and 1 volume of oxygen are mixed, being at the same pressure before and after mixing. This experiment has lately been made by Berthelot, whether with sufficient precision for the purpose is not known at this moment. It is also desirable that the ratio of the combining

* President's address, delivered before the New Haven meeting of the American Chemical Society.

volumes of oxygen and hydrogen should be measured with the gases contained in vessels of the dimensions of those used for obtaining their densities.

If these syntheses and these studies of ratios of densities and combining volumes should agree as well as it is safe to expect, we should know the atomic weight of oxygen as confidently as we can know it while the value rests on a single chemical process, the combination of the two gases to form water.

But this is not so much as is desirable. We know the atomic ratio between silver and oxygen with considerable confidence, because this rests not on a single chemical process but on eight different chemical processes, which give eight independent results, and because these eight results agree. Is there, then, any chemical process by which the atomic ratio of oxygen and hydrogen can be determined, other than the analysis or synthesis of water? Is there any element whose atomic ratio to oxygen is well known, whose ratio to hydrogen is capable of accurate direct determination?

It is probable that, given an adequate equipment, the direct ratio of hydrogen to chlorine, of hydrogen to sodium, of hydrogen to magnesium, or of hydrogen to aluminium, could be determined with sufficient precision for the purpose, provided that the ratio of chlorine to oxygen, of sodium to oxygen, of magnesium to oxygen, and of aluminium to oxygen are well enough known. This may not now be the case with aluminium or magnesium, but is the case with chlorine and with sodium, whose atomic ratios to oxygen may be fairly assumed to be known within 1 part in 2,500. If, now, we can determine the ratio of chlorine to hydrogen, or of sodium to hydrogen, to 1 part in 5,000, we could compute, by a new method, the ratio between hydrogen and oxygen. If this should agree with the present value, within some such quantity as 1 part in 2,000, we should be as confident of the truth of our value of the atomic weight of oxygen as we can well hope to be.

The difficulties in making a complete synthesis of hydrochloric acid are not small, nor are they all well understood. Some unexpected circumstance may be prohibitive. But there is good reason to hope that 3 or 4 or 5 grammes of hydrogen could be weighed, that a nearly equivalent quantity of chlorine could also be weighed, that the two could be combined, and that the product could be weighed. One serious difficulty would be found in attempting to prepare pure chlorine, but the difficulty does not seem insuperable. The manipulation of the corrosive element requires invention, but seems not difficult. For the collection of the hydrochloric acid in a weighable form, there seem to be alternative methods, not very troublesome of execution, unless unforeseen difficulties are encountered. If the ratio between hydrogen and chlorine could be determined to 1 part in 5,000 or to 1 part in 10,000, it would be a very interesting addition to our list of known constants, most helpful in establishing confidence in the ratio between oxygen and hydrogen.

So, also, if sodium can be prepared of sufficient purity, or of sufficiently constant impurity, it seems possible to weigh 100 or 200 grammes, to act on it with water in such a way as to produce a slow evolution of hydrogen, and to determine the weight of this hydrogen by loss. Whether sodium can be obtained sufficiently free from absorbed hydrogen and whether it can be prepared for weighing without attacking the vessels which contain it, are questions which need further experiment. It is probable that a vessel of platinum-iridium alloy could be made which would make success almost certain, but at considerable cost. In this case also, if the ratio between sodium and hydrogen can be determined to 1 part in 5,000, or 1 part in 10,000, the result would inspire confidence, or, if it must be distrust, in our present value for the ratio between oxygen and hydrogen.

These suggestions, necessarily tentative in their nature, are submitted to the American Chemical Society, in the hope of obtaining from those who do me the honor to listen to them or to read them, expressions as to the desirability of making experiment in the lines described, and discussions of the new methods indicated as possible.

MATERIA MEDICA; ANCIENT AND MODERN.*

By E. S. EVERETT, Portland, Maine.

I DESIRE to-night to invite you to step back with me a hundred years or more, and look at some of the articles then regarded of as much value, and as great specifics as some of the newer medicines and chemicals are at the present time. I presume, however, the old articles were not introduced to the physicians in those days, by specialty men, and most of them surely could not be recommended by their elegant appearance, or their delicacy of flavor. These latter points are later advantages.

I am not intending to go back to the time, some fifteen hundred years before Christ, when the profession of a pharmacist was recognized by the Creator himself, by giving explicit directions for an anointing oil, for temple use, to his servant Moses, in the following words: "Thou shalt make an ointment after the art of the apothecary; it shall be an holy and anointing oil," and to make this indorsement still stronger, the directions are repeated, "Thou shalt make it a confection after the art of the apothecary, tempered together, pure," but will speak of the "Materia Medica" of a little more than a century ago.

I am fortunate in having in my library, an Edinburgh Dispensatory, published in 1786, which is, as the title page assures us, "An attempt to collect and apply the later discoveries." It certainly seems to the thoughtful person, that the people who lived in the older times must have had better constitutions than those of the present day, or the sick would have given up at once rather than take the medicines prepared for them. This book omits a great mass of medicines which had been printed in former dispensatories, but still included some preparations of whose efficacy they thought there was no question. Two preparations, published in a book bearing date of 1667, were considered specifics, and are worthy of notice for the wonderful cures they made. The first was a distilled oil of mercury, which was prepared with much care and would, to use the words of the old physician, "Purify the blood by the sweat and urine so that it cures all distempers that arise from the impurities thereof." It has this additional indorsement: "The truth is, they that have this, need but few other medicines." Much was made of the retort and still, and perhaps one of the most interesting, as well as mistaken, formulas used was one which was called

SPIRIT OF CRANIUM HUMANUM,

which was made as follows: Break a human skull in fine pieces, place in a retort, and apply heat as usual. By following out the process, three distinct liquids are obtained. The first is a light yellowish spirit, this helps falling sickness, infirm stomachs, opens all obstructions, strengthens weak parts, and is indeed a panacea. The second distillate obtained is a red oil which will cure deafness, preserves youth, and, if used, will not permit corruption after death. The third is a wonderful clear water, called "Mother of Balsam." This takes away pimples and blemishes of the eye, comforteth a cold head, and will help the memorative faculty. It retards gray hair, cleareth the spirits, healeth the nerves, expelleth all water out of the body. It taketh away forgetfulness, comforteth the memory and it cureth a crook back, if rightly applied.

I found on a time-faded paper in this old book, a prescription and course of treatment for scarlet fever, which some of you professional men may wish to follow. It was dated 1804, so the copyright has run out, and you may feel free to use it. I am also quite sure that you will have to make and mix it yourself, as none of the pharmaceutical laboratories carry it in stock. It is as follows: "Give at the commencement of the disorder, one or two small doses of calomel with diaphoretic antimony. Gargle the throat frequently with a mixture of equal quantities of brandy, vinegar, and sage tea, with a little alum dissolved in it. Also, give vinegar, saturated with common salt, once in two hours, or oftener, and, occasionally a little laudanum. When the fever abates, give the decoction and tincture of the bark." On this same paper also appears the following valuable prescription for worm powder. Prescription:

Tin	175	grains.
Quicksilver	70	"
Crab's eyes	35	"

Mix and powder, and take fifteen or twenty grains night and morning for one week.

Many of our principal chemicals and drugs were in general use at the commencement of this century, however, and I have no doubt others then in use are as efficacious to-day as ever, but have been crowded out and forgotten in the rush of new things. Some of the drugs would be difficult to find at the present time. Some, I have no doubt, have lost their identity, and I feel quite sure that, should a customer ask for a piece of "Infernal Stone," he would hardly find a clerk who would pass him a piece of "Lunar Caustic."

The commonly used medicines seem to have been first classified with the desire to have uniform working formulæ, under government direction, in Nuremburg, in 1542. In 1617, the apothecaries in England succeeded in securing a law confining the sale of medicines and the compounding of prescriptions, to people of their craft, thus debarring the grocers of those days from longer being competitors.

It may be of interest to you to know that the first Pharmacopœia of the United States was published in 1820. A convention was held January 1 of that year, in the city of Washington, and consisted of a representative body, composed of delegates from the four districts of the United States. These delegates were chosen in response to the suggestion of Dr. Lyman Spaulding, of the New York Medical Society, as the need of uniform, reliable formulæ for medicinal preparations was apparent to all. As a result of this meeting a revision of The Pharmacopœia has been made every ten years since, and we shall see a new one in the course of another year, bearing date of 1900.

During the seventeenth century there seems to be but two divisions of medicines, called simple and compound. The former were very numerous, and consisted of some minerals, but a much larger number of articles from the animal and vegetable kingdoms. Among the minerals used in early medicines, precious stones and jewels had a high place. A topaz, if hung about the neck, was supposed to resist sorrow and recreate the heart. The onyx kept the whole body in a good condition. Coral was a cure for many ills. The emerald was equally effective. The loadstone, one Cabeus, the Jesuit, tells us, if taken inwardly, like viper's wine, will restore one to his youth.

By far the larger part of these are now in entire disuse, and it seems incredible that such articles could ever have been considered of medicinal value. The whole system of medicine was one of ignorance and deep superstition, magic and vile concoctions.

Among the simples, were such toothsome delicacies as millipedes, wood-lice, hog-lice, snails, and bufo, the toad. The way to gather and prepare these, first was to find them, in cellars, under stones, and in cold, moist places. They had a faint, disagreeable smell, and a somewhat pungent, nauseous taste. They were dispensed dried or powdered. Another peculiar compound was the following:

OIL OF BRICKS,

which consisted of soaking bricks in olive oil until saturated, and then breaking them up and distilling the resulting loathsome oil. This was considered great for tingling of the ears and deafness.

Another, an

OINTMENT AGAINST WORMS,

which had directions as follows: "This ointment is rubbed on the bellies of children for destroying worms, and, it is said, with good success." Lumbrice, or snails, were supposed to cool and cleanse the viscera, and were recommended, from their abounding with a viscid, glutinous juice, for consumptives. It was suggested that they be boiled in milk. How would a snail emulsion taste?

Some samples could be readily taken, but when we think of moss from a human skull, excrement of dogs, mice, geese, and even of human beings, we of this enlightened Academy, simply stand aghast at the science of the past. Should the pharmacist of the present receive a prescription for blind puppies, dried, powdered, or in any form, he would think the customer a lunatic at large, yet this was a standard drug, which was frequently dispensed when a gilded alligator served for the apothecary's sign, when jars of adders and worms adorned his counters, and dried flying fish, tortoise, etc., hung suspended from the rafters.

Among the compounds were names, not all of which are now familiar:

Confection,
Epithems,
Treacles,
Magesteries,
Juleps,
Lohochs (a soft compound, designed to be licked or slowly swallowed).
Auhalt water,
Arquebufade water,
Boluses,
Ales, and vipers' broth.

Some of the confections were fearfully and wonderfully made—one, known as Confectio Damocratis, contained forty-six (46) ingredients, including two and one-half (2½) drachms of bellies of skinks.

It requires no small amount of skill to compound the famous Venice Treacle, which contained sixty (60) ingredients, besides three (3) ounces of dried vipers.

This was also called the Theriaca of Andromachus, who was Nero's physician. The most extravagant praises of its virtues were given by the early writers; the principal of which consisted in its claim to being a preservative against all kinds of venom. Whoever took a proper quantity of it, in the morning, was insured against being poisoned during the whole day. This was confirmed by the example of its supposed inventor, who was so fortified against poisons by its constant use, that none of them would have any effect upon him.

Poison, in some form, seemed the danger greatly feared by all, and they busied themselves in contriving compositions which would counteract their effect. It does not appear, however, that the ancients, who originated many of such antidotes, were acquainted with many real poisons, except cicuta, belladonna, aconite, and the bites of venomous things, and for these, they knew of no antidote.

When pharmacists or others of the present day, say Juleps to us, something of agreeable thought, or a mint flavor comes to the mind, but—

Julep of camphor,

Julep of assafœtida, called fetid julep, binding julep, or even alexapharmic julep does not cause our mouths to water in pleasant anticipations.

Medicated ales were, for a long time, a favorite form of medicines, and perhaps have soon been forgotten.

Aperient ale,
Cephalic ale,
Diuretic ale,

and Scorbutic ale were the most common always, excepting the bitter ale which I have understood is now sometimes used.

Now, in view of some of the mixtures to which I have called your attention, did not Shakespeare consult his apothecary friend when he made up his formula for his

"WITCHES BROTH."

"Round about the cauldron go;
In the poisoned entrails throw—
Toad, that under the cold stone,
Days and nights has thirty-one,
Swelt'red venom sleeping got,
Boil those first in the charmed pot.
Fillet of a finny snake,
In the cauldron, boil and bake;
Eye of newt and toe of frog,
Wool of bat, and tongue of dog,
Adder's fork, and blind-worm's sting,
Lizard's leg, and owlet's wing,
For a charm of powerful trouble
Like a hell-broth, boil and bubble.
Scale of dragon, tooth of wolf;
Witches mummy, maw and gulf,
Of the ravin'd salt sea shark;
Root of hemlock digged in the dark,
Liver of blaspheming Jew;
Gall of goat, and slips of yew,
Slivered in the moon's eclipse—
Nose of Turk and Tartar's lips,
Finger of birth-strangled babe,
Ditch delivered by a drab,
Make the gruel thick and slab;
Add thereto a tiger's chauldron
For the ingredients of our cauldron,
Cool it with a baboon's blood—
Then the charm is firm and good."
"Double, double, toil and trouble,
Fire burn and cauldron bubble."

Now I have selected some of the extreme examples for my paper of to-night, and do not wish that any of you should go to your homes thinking that all medicines were such as I have mentioned. Such an impression would be far from the truth; the bulk of the medicines dispensed were less complicated, and without the disagreeable features. The doses were more heroic, but little thought was given to taste and convenience of the articles administered; still, we are using, in some form, many of the drugs then found useful. We use quinine and cinchonidia in a konseal, or elegantly coated pill. They had their shivering ones take a teaspoonful of the powdered Peruvian bark. They were unacquainted with morphine, but the results were obtained by opium in its natural state, or by their Thebaic or Pacific pill.

Alum, camphor, borax, senna, rhubarb, chamomile, foxglove, henbane, nux vomica, and hosts of other drugs used are standard medicines of to-day.

I wish to emphasize particularly that while the formulæ given, and the medicines mentioned, seems crude, outlandish, and sometimes hideous, yet, throughout them all, great skill was required for their preparations, as much, in fact, as is required to-day, although of an entirely different character. That the apothecaries of the old days, as are the pharmacists of to-day, were among the best educated men of the times, is admitted by all. Their skill in using retort, furnace, and still is unsurpassed by their craft of the nineteenth century. However true it may be that they were spurred on in their work, continually, by the ever-present hope of discovery of an elixir of perpetual life, or eternal youth, the fact of their skill remains unquestioned.

I have only tried to interest you in some of the oddities of the past "Materia Medica," and the next speaker will tell you of the present, and the high

* Paper read under the Section on Materia Medica and Pharmacy, at the thirty-seventh stated meeting of the Maine Academy of Medicine and Science, held January 8, 1900.

scholarship demanded to-day. I think you will see a marked difference; still, could we look into the future two hundred years, we might learn that the medicines of to-day will be regarded as crude, imperfect, and utterly useless.—Journal of Medicine and Science.

GUN-DRILL ON A GERMAN TRAINING-SHIP.

Our illustration shows the after part of the starboard upper deck of the "Carola," of the German Imperial Navy, before she was converted from a cruiser into a special training-ship for instruction in rapid-fire gunnery. The crew of a rapid-fire 15 c. m. rifle are going through their gun-drill. The range and traverse angle having been given, the piece is trained right aft and the order given to fire. When the enemy is directly astern, the gun-crew, in obedience to their captain's orders, drop flat upon the deck, to avoid the danger of raking, but ready to continue firing when the piece is again in line with the target. As the enemy passes across the guns the men are ordered to fire promiscuously and each gun-crew arises and discharges its piece as rapidly as possible. Our illustration is taken from Moderne Kunst.

PEARL FISHERIES OF THE DUTCH EAST INDIES.

Shells constitute one of the most important articles of exportation from Macassar. Up to the beginning of this decade they were sought almost exclusively by natives, fishing in the shallow waters in the bays, without using any diving apparatus. In 1893, according to the United States Consular Agent at Macassar, Celebes, an English company sent a schooner and some luggers to the Aroo Islands to try exploitation in deeper waters. This company appears to have had a good measure of success, for its fleet left the archipelago only when forced by a Dutch law of 1894, to the effect that only inhabitants of the Netherlands and Netherlands India, or companies established in these countries and under the Dutch flag, should be permitted to engage in pearl fishing. In 1896, the Eastern and Australian Trading Association of Amsterdam began operations, which, however, do not appear to have been successful, for the company liquidated in 1898. In the meantime, residents of Dutch India were beginning to pay more and more attention to the shell fisheries, and Europeans, Chinese, and Arabs endeavored to make arrangements with the native chiefs, in whose territorial waters shells were supposed to be, and who generally granted the privilege of fishing for a fixed sum in cash, or a percentage of the quantity fished. Such contracts, however, were legal only after the sanction of the Governor-General of Dutch India, which has been accorded without charge. Shell fishing is at present carried on on the east coast of the Aroo Islands, on the east coast of New Guinea, on the Halmaheisa, and the islands adjacent, on the east coast of Celebes, and the Timor group. An undertaking on a larger scale is the Djoempandang Maatschappy, established at Macassar in 1898, with a subsidized capital of £12,000, for fishing in the Timor waters, with a fleet of one schooner and ten luggers. The company has succeeded in securing apparently valuable concessions. The chief market for mother-of-pearl shells is Paris; only small quantities are shipped to London, Hamburg and Amsterdam. There were exported in 1896 about 150 tons; in 1897, 200 tons; and in 1898, 250 tons. There is no doubt that 1899 will show a further considerable increase. Notwithstanding this augmentation, prices have been fully maintained. Aroo shells sell at Macassar at £140 per ton; Timor, Ceram, and New Guinea and Celebes shells at £80 to £100. Fishing is allowed during the whole year by the government, but is occasionally prevented by the monsoons. Besides mother-of-pearl, there are also found in the archipelago cheaper varieties, which are obtained exclusively by the natives, and used in Germany and England for button manufacture, etc. Of bunda, or black-edged shells, there is an export of about 80 to 100 tons yearly. Green snail shells are exported to the extent of at least 100 tons yearly, and exports of mussel shells amount to about 30 to 50 tons annually.

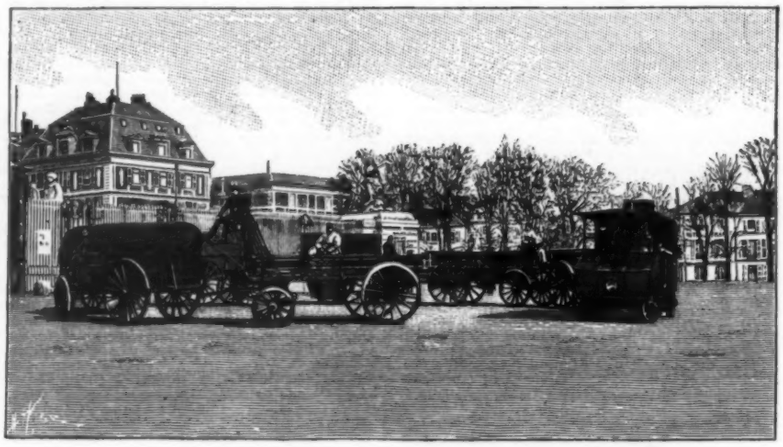


Fig. 1.—EXPERIMENT IN TURNING A SCOTTE TRAIN.

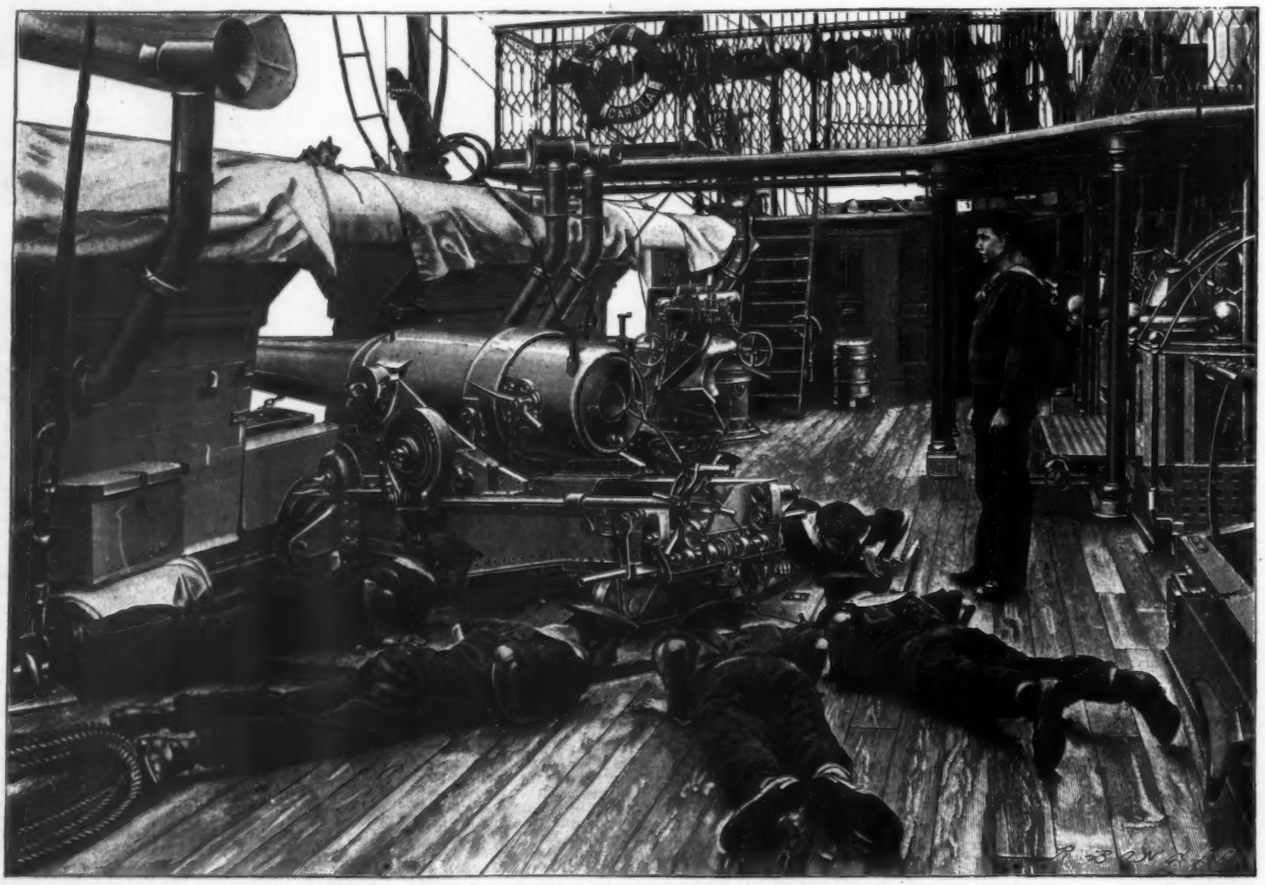
WAR AUTOMOBILES.

When, about twenty-five years ago, the French military authorities made the acquisition of road locomotives, they believed that they had found an engine that was to effect the heavy conveyances of the army and make up for the inadequacy of horses for the moving of bulky and weighty material. At this epoch, it was a question of rapidly arming some newly constructed forts with guns of considerable weight which it was difficult and expensive to haul by ordinary methods, that is to say, by means of horses. What, then, were the stumbling blocks in the way of the use of such engines, since they have disappeared from the service of the army?

They were of several natures, and consisted principally in the excessive weight and the difficulty of maneuvering the locomotives, and the want of power in the boilers, which, were, nevertheless, capacious. The weight of these road locomotives of two different types (a large and a small model), which was respectively 15 and 18 tons, involved the rapid deterioration of ordinary roads, and forbade them access to country roads of which the metallic bridges were incapable, in most cases, of supporting loads greater than 17,600 pounds, distributed over two axles.

The steering apparatus did not act quickly enough in a turning at right angles and rendered the entrance into fortified works with obstructed gates, drawbridges, etc., if not dangerous at least very difficult. The want of power of the boiler necessitated numerous stoppages along the road for putting them under pressure; and in journeys upon roads that were somewhat broken, considerable of a reduction had to be made in the weight carried. Such as they were, however, the fact must be recognized that these road locomotives rendered numerous services in the carriage of heavy artillery material, since, when it is necessary to employ horses, the number of the latter must be so great for such maneuvers that, in turning about, the front teams no longer haul in a straight line, and it then becomes necessary to have recourse to the use of capstans, the maneuvering of which is lengthy and always difficult.

Things were in this state about ten years ago, when appeared the first steam automobiles of a relatively



GUN-DRILL ON THE GERMAN TRAINING-SHIP "CAROLA."

much lighter weight (5 to 6 tons) than their predecessors and of at least equal power. Such results were due to the great improvement introduced into the processes of mechanical manufacture and the use of steam at a high tension produced in new boilers with a rapid vaporization under a small bulk.

When in the train of the different races and competitions that had taken place up to 1894, the Minister of War consulted the military commissions that had closely followed the progress that had been made, he found that they were of the opinion that the Scotte traction engine was the type of automobile that seemed to answer the requirements of the army best. Some experiments of the most varied character, as shown by the photographs which we reproduce, were undertaken as long ago as the beginning of the winter of 1897 and were continued up to the course of the year 1899. They proved that the Scotte traction engines were capable of effecting all the conveyances required by armies in the field and the carriage of siege parks and large pieces of artillery. A Scotte train composed of six carriages of artillery or military equipments turns about and performs its revolutions within a radius of 11¼ feet (Fig. 1), and is capable of passing over all the classified roads of France.

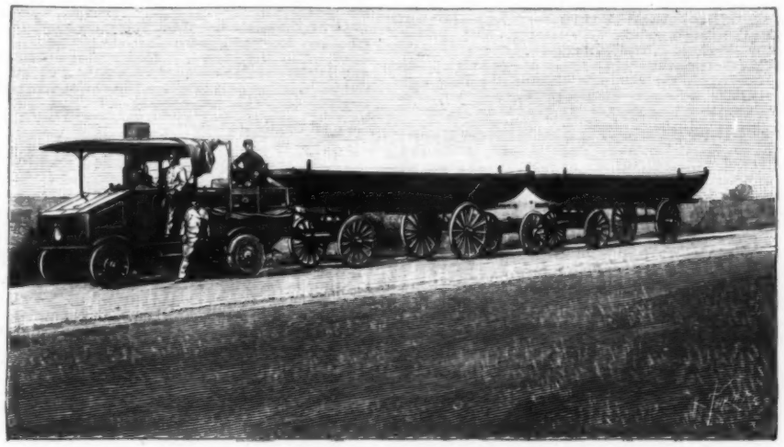


FIG. 2.—CARRIAGE OF PONTOONS FOR BRIDGES.

Here, then, we have a great problem solved, since we now have an engine which will advantageously replace horses, the number of which will continuously decrease, seeing the progress that automobilism is making. The advantages over animal traction are indisputable. In the first place, there is a reduction of about a half in the length of the convoys upon the road, and a reduction in the personnel necessary for the new mode of traction, which will employ but 120 men, while for the same convoy animal traction requires 180. The guarding of the sides of these automobile convoys on a campaign would require but half the number of men as a consequence of a reduction of the length upon the road. In forced marches, since the mechanical motor does not become wearied, it would permit of more extended strategetic movements while ordinarily the latter have to be limited to the journey that horses can make in a given number of hours.

The following examples will make apparent the advantages of automobile traction in a still more striking manner. It has been proved that 25 Scotte traction engines are capable of supplying cartridges at 60 miles distance and in 18 hours, to an army corps of 60,000 men; and that it is possible to move in one night to a distance of 9 miles, 50 nine-inch guns of the weight of 24 tons each.

If, in 1870, the Prussians had had engines of this kind at their disposal when they began the siege of Paris, they would not have had to wait three months and a half before being able to bring their guns into position. It was necessary at that epoch to bring from Metz 960 carriages and more than 2,000 horses. The 2,000 carriages and the horses for which a requisition was made for duty around Paris, as well as the teams of the third German army, had great trouble to supply ammunition for an attack that once begun could not be interrupted at any cost.

As a traction engine replaces 32 horses, it will be seen that hardly more than 200 engines would have sufficed to permit them to begin the bombardment within but a few days after the invasion: and, as the defence had not been able to make sufficient preparations, the consequences would have been still more disastrous for us.

In future wars traction automobiles will necessarily be called upon to play a very important part in conveyances and the supply of armies in the field.

For the foregoing particulars and the engravings, we are indebted to La Nature.

A new treatment for tuberculosis has been developed by Dr. Mendel, of Roubaix, France, and is described at length in the January issue of "Consular Reports." It consists in the injection of certain essential oils into the trachea. The solution used is made up of 100 cu. cm. of sterilized olive oil, to which is added 5 grammes each of the essential oils of thyme, eucalyptus and cinnamon. From 9 to 12 cu. cm. are injected daily into the tracheal duct by a curved syringe On September 9, Dr. Mendel had treated 27 tubercular patients by this system with results which thus far appear to be notably beneficial, especially in the case of patients in the earlier stages of the disease. The theory of the treatment is based on the experiments which show that the vapors of the essential oils used have a powerful antiseptic effect on tubercular germs. Copies of the issue of "Consular Reports" containing a full account of the treatment can be obtained by addressing the Bureau of Foreign Commerce, State Department, Washington, D. C.

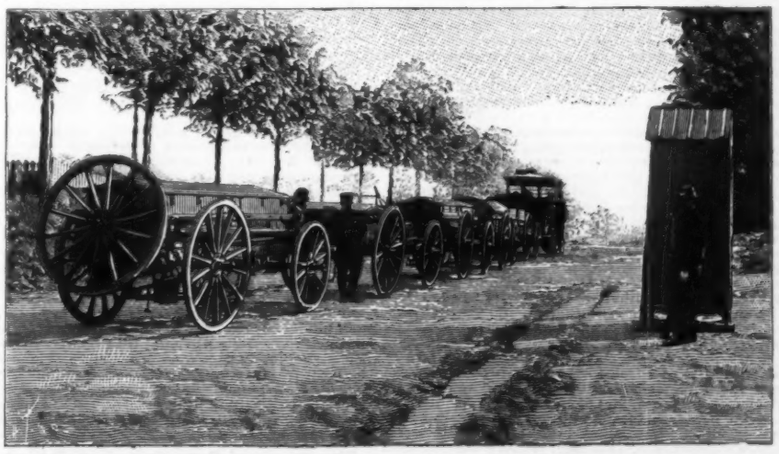


FIG. 3.—CONVOY OF AMMUNITION UPON THE COAST OF SATORY.

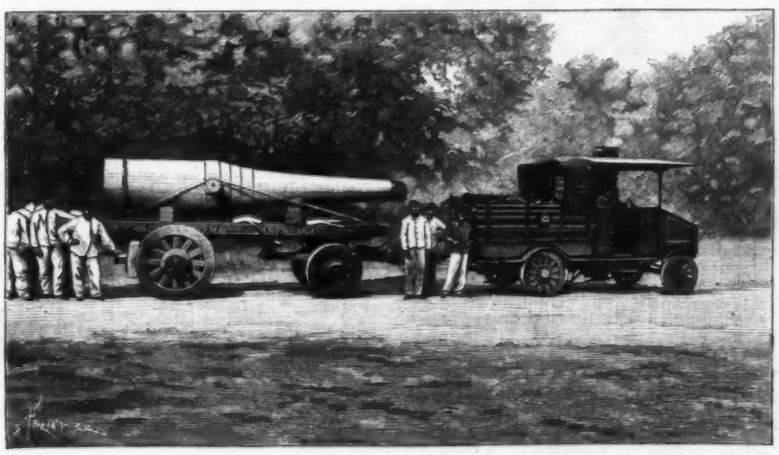


FIG. 4.—CARRIAGE OF A LARGE SIEGE GUN.

ORIGINATION OF PRINTING TYPES BY PHOTOGRAPHIC METHODS.*

By THOMAS BOLAS, F.I.C., F.C.S.

VIEWED at first sight the making of an electrotype matrix, suitable for type-founding, from an original in black and white, appears to be a very simple and straightforward operation; so simple in fact that it seems surprising that the expensive cut-steel punch should still survive as an original from which to reproduce printing types.

Let a page or sheet of characters, sketched with a brush or written with a pen, be photographed, and a phototype plate be made by one of the various well-known processes. Any letter of such a plate may be used as a model upon which electrotype copper is deposited, so as to form a matrix for casting type. It will, however, be found that such a matrix will differ considerably from an ordinary matrix formed by driving the steel letter punch of the type-founder into a block of copper, the difference being in the matter of the slope or angle of relief, from the face of the letter toward the stem or shank of the cast letter.

The original steel punch used for small characters has ordinarily an angle of relief equal to about 6° (or, to put it in another way, the angle of the face to the immediately adjacent part of the side is about 6° more than a right angle; or 96°). When such a punch is used in making the copper matrix, the face of the cast type, which stands at a relief on the end of the body or shank may be brought close to any margin of the shank, a very important practical matter in type-founding; and then so little will project by reason of the slope of the punch, that a very slight rubbing down of the finished type will suffice. Indeed one side of the punch may be—and sometimes is—actually at right angles with the face, so as to facilitate casting the corresponding part of the type close to the edge of the body or shank. If the matrix extends beyond the body-mold, part of the face of the letter projects as a kern, and then the inconvenience of a considerable angle of relief in the punch, will obviously become more pronounced.

To illustrate this matter I pass round the following:

Group a.—Original steel punch.

Matrix.—Letter cast in this matrix on a body exactly corresponding to the face.

Group b.—Similar set in which the character is cast on a body smaller than the face of the character; the type being, if we may use the expression, "kerned all round."

If we look at an ordinary phototyped plate we shall see that the slope from the face of any line or character to the general level of the hollows or whites is very different from that of the type-founder's punch. In the case of an etching on metal there is generally an almost vertical wall for a depth of about one two-hundredth of an inch, and then we have a buttress which is not angular but generally more or less curved in the sense of being concave toward the observer. This buttressed form of the side appears to be conducive to long-run printing, as the metal is strengthened by the buttress against crushing down or flowing; although if the stress in ordinary typographic printing were surface-wear, the case would be different. At any rate, I have satisfied myself that the buttress form of the slope is no disadvantage in printing.

Quite apart from any question whether the buttress-like slope of the typographic plate is good or bad in relation to ordinary typographic printing, it is undoubtedly a great inconvenience in relation to type casting, if electrotype matrices are made directly from the letters of a phototyped plate, as the buttress will then project as a sharp edge from the cast body, and will often necessitate so much rubbing down as to be impracticable.

The following details of manipulation—the stages of which I show—indicate how very satisfactory matrices can be made from a phototype plate; this plate being

* Read at the ordinary meeting of London Royal Photographic Society held at No. 66 Russell Square, on Tuesday, December 12, 1899. Mr. Chapman Jones, F.I.C., F.C.S., Vice-President, in the chair.

itself reproduced from manuscript letter; or, may be, the page of an old book the type of which it may be desired to reproduce. In making the matrix from a character in the plate, the first thing is to saw out this character from the plate* and then to lay the cut-out piece face downward in the hollow of such a "jig" as I show you, the depth of the jig being adjusted to the height of the face above the shank or body in the case of the particular body-mold to be used. (In this particular instance the depth of the jig is 0·049 inch.†) The back of the piece bearing the character is now filed away until the thickness of the piece corresponds to the depth of the jig; and the character is now soldered to a thick strip of flat brass, a highly fusible solder being used.‡ Before electrotyping the character as it stands soldered to the flat plate it is necessary to file one side or more so as to make an even slope up from the base plate to the face of the character. For this purpose I cut a file such as I show you; a flat file, all "safe" excepting one edge which makes an angle of 96° with one of the flat faces; and consequently 84° with the other flat face; this file being used to trim up the character on four sides (if necessary) until the face is just short of being cut into. We thus get a "photographic punch" which for casting purposes is equal to the ordinary steel punch. Before electrotyping on this punch, it saves much time to rule fiducial lines having proper relation to the mold in which the type is to be cast. These can be ruled with simple bridge-like gages from the margins of the character. When the electrotype is made, and backed up in the way which is usual for electrotyped matrices, nothing remains to be done but to saw off and file to the fiducial lines and reproduced on the electrotype—the depth of the matrix having been determined by the jig already mentioned.

The "photographic punches" and matrices I show you now belong to a set which I commenced to make about fourteen years ago, and some of which I showed at a lecture delivered to the Society of Arts on March 3, 1890. In the course of this lecture I had occasion to refer to the excellent work done by Mr. Alfred Dawson in the way of producing types by the photographic method; still, as far as I know, there have been very few followers along this very easy path.

In showing you the actual operation of casting types in a hand-mold I would point out that this is a method of casting standing quite by itself. In order that the pouring into the mold may be steady and in one quick run, a measured quantity of the melted metal is taken out of the pot with a small ladle or spoon, and this dose of metal is poured quickly into the mold so that the stream drives straight against the face of the matrix, while almost at the same instant, the mold is raised suddenly or "heaved" so that the metal is driven, by its inertia, well into the intricacies of the matrix. In casting by the machine, a method universal now for such type as is required in large quantities, the same principal of driving against the matrix is adopted; but the metal is projected by a small squirt or pump.

The photographic method, substantially as described above, is very convenient for making matrices which are to be set side by side for casting logotypes; only, of course in this case the matrices must be trimmed close at the sides. Matrix setting by machine (linotype) is now, it must be remembered, a commercial reality; but matrix setting by hand, as practised by Herhan a century ago, may in many cases be a useful process, especially when allied to photographic reproduction.

It seems to me that if photographers and printers realized the ease with which matrices for type-founding may be made by such a method as that described above, we should have a return to the free or writing style in printed characters. The characters in all the early books were careful copies of current styles of writing, and to give effect to the idea of writing being reproduced, it was the custom to cut many characters of the same name, and to intermix them in the boxes of the case. So far was this idea of variety carried out by Guttenburg, that his Bible (the Mazarin Bible) is often spoken of as being printed from characters, each of which was specially cut or engraved—a mistake obvious enough to anyone who looks into the matter.

By adopting some such method as is here detailed, amateurs in photography could easily originate or cast type for use by themselves, and authors of books could originate the letters used for their own works.

Considering the ease of working, I take it that the matrices for a font of ordinary book size type could be produced and justified at a cost of about 8d. each, if the work were kept going on a commercial scale. The justifying, which is ordinarily so troublesome with strikes from punches, is scarcely worth considering in the method described, as it is done almost automatically; especially as regards the depth of the matrix and the parallelism of the face of the letter to the end or shoulder of the body or shank.

As objects of interest indirectly bearing on the subject I have placed on the table several sets of original steel punches.

Cleared out of an old London type foundry, these were purchased as a sort of job lot by a dealer in miscellaneous goods, and from this gentleman (Mr. Jewell, of Sidney Grove, Sidney Street, E. C.) I purchased the greater part, as an unpromising mass of rust and packages—some of which appeared to have been unopened for half a century. About a hundred sets of punches were made up on sorting out; a few complete sets being quite undamaged by rust, owing to the faces having been dipped in melted wax. As far as I know there are no collections of historic punches in this country, as is the case at Antwerp and Haarlem. I also place on the table the specimen book showing impressions of types from the Haarlem collection of punches—these punches going back to about 1470. This valuable and now rare book was presented to me some twelve years ago by the owners of the collection, Messrs. J. Enschedé & Son.—Journal of the Royal Photographic Society, January, 1900.

* When the original is zinc, a cast in stereotype metal is used instead of the original, and this for an obvious reason.

† The depth of the jig which was shown is capable of easy adjustment by means of packing placed under the hard steel plate.

‡ See my Cantor Lectures on Stereotyping, published by the Society of Arts in 1890, p. 18.

TRADE NOTES AND RECEIPTS.

Polishing Soap for Metals.—Pour water over 48 kilogrammes of pure grain soap in shreds and dissolve it therein by boiling. Mix with the solution 6 kilogrammes of the best whiting, 3 kilogrammes of white-lead, 3 kilogrammes of tartar, and 3 kilogrammes of burnt magnesia.—Farben Zeitung.

Hair Dye.—As a harmless and simple hair dye, M. Joseph recommends argentum-vaseline (1 to 20 per cent., according to the desired shade), i. e., a salve consisting of yellow vaseline with admixture of 1 to 20 per cent. of silver nitrate, previously dissolved in as little water as possible. The comb is coated with this salve every week to every fortnight and the hair carefully combed through.—Deutsche Medicinische Wochenschrift.

Mixing Plaster of Paris.—For stirring plaster of paris, filtered rainwater or sour milk is best employed. Within twenty-four hours the gypsum has become exceedingly hard. Fine marble dust increases the degree of hardness. An addition of 83⅓ grammes of sal-ammonia to ¼ kilo of plaster is commendable.

One may also proceed as follows:

Shape the gypsum into a cone in a dish, and slowly pour in water or sour milk till the cone has absorbed it up to the point. Now only commence stirring, avoiding all premature mixing.—Neueste Erfindungen und Erfahrungen.

Production of Soap Powder.—I. Oleic soap 24 kilos, water 30 kilos, ammonia soda (98-100 per cent.) 86 kilos.

II. Oleic soap 20 kilos, Glauber's salt 16 kilos, water 31 kilos, ammonia soda (98-100 per cent) 23 kilos.

III. Oleine 20 kilos, water 32 kilos, ammonia soda (98-100 per cent.) 35 kilos, soda-crystals-lye 50 kilos.

Oleine and water are entered in the kettle, heated over the fire and the ammonia soda, etc., stirred in by small portions. The thick paste is then taken out and placed on sheet zinc to dry. When perfectly dry, the soap powder is ground into a fine dust in a mill and filled in packages.—Seifensieder Zeitung.

Black Ink for Rubber Stamps.—Intimately mix black printer's varnish with the color in a suitable tin dish and grind it very finely on a paint mill. If the latter is not at hand, the grinding may be done on a stone or glass plate by means of a muller.

Following are some receipts for black stamping ink:

1. Black varnish, 10 parts; finest lampblack, 3 parts.
2. Black varnish, 10 parts; lampblack, of inferior quality, 4 parts.
3. Black varnish, 10 parts; ordinary lamp black, 6 parts.

An excellent black stamping color, which does not run, and yield handsome impressions, is produced from finest lampblack 10 parts, mucilage 4 parts, glycerine 1 part, water 3 parts.—Papier Zeitung.

Luminous Glass Letters.—According to the Sprechsaal, luminous glass letters are now manufactured in Germany.

The letters are made, in all colors, from pressed glass and are hollow, being open in the back. Before being attached to the tin letter backs fastened to the walls, etc., they are filled with luminous substances.

The operation for applying a firm name or inscription of any kind, such as street name, house number, etc., to the wall in luminous letters is as follows:

The flat tin letters, which form the backing of the hollow ones of glass, are secured to the masonry, etc., by a few nails. Upon these letter backs, whose edges are bent forward, the hollow glass letter is securely fastened by a pin with screws.

The inside of the glass letters is previously filled up with luminous mass, which can now be had from chemical factories. It is obvious that owing to the filling being completely protected from air and moisture by the tight-fitting closure, it will remain intact for a long time, and surpasses luminous paint coatings in every respect. If the luminosity of the mass should cease after a long time, the letters can be taken off without much trouble and filled anew.

Blue, Brown and Green Coloring of Prints on Gelatino Argentic Bromide Paper.—This process is based upon the action of solutions of iron and uranium salts on metallic silver. This toning causes a strengthening of the picture, which should be taken into account in making the prints.

The directions are as follows:—

BLUE COLORING:—

(*a.*) Ammonia—ferric citrate	1	gramme.
Distilled water	100	c.c.m.
(*b.*) Red prussiate of potash	1	gramme.
Distilled water	100	c.c.m.
For use mix:—		
Solution (*a*)	50	c.c.m.
Glacial acetic acid	10	"
Solution (*b*)	50	"

The mixture is clear and green in color. The fixed silver bromide pictures must be well soaked previously. The coloring appears already after 1 or 2 seconds and consists in a bluish-black, which promptly changes into an intense blue. When the desired shade has been attained, wash until the water runs off clear.

BROWN COLORING:—

(*a.*) Uranium nitrate	10	grammes.
Distilled water	1000	c.c.m.
(*b.*) Red prussiate of potash	10	grammes.
Distilled water	1000	c.c.m.
Of this mix:—		
Solution (*a*)	50	c.c.m.
Glacial acetic acid	10	"
Solution (*b*)	50	"

Maintain the rotation. The fixed and washed silver prints are dipped in the bath and treated same as for the blue toning.

MALACHITE-GREEN COLORING:—

Same is obtained by use of both solutions:—

Uranic nitrate solution, 1:100	25	c.c.m.
Solution of ammonia-ferric citrate	25	"
Glacial acetic acid	10	"
Solution of red prussiate of potash, 1:100	50	"

—Photographische Correspondenz.

SELECTED FORMULÆ.

To Remove Anilin Stains from the Hands.—Ammonia water will remove many of the stains. The use first of a little bleaching powder and subsequently of strong alcohol will remove pretty much all. The same agents will probably remove other stains mentioned. Where the hands have become begrimed or the dirt and stains have become "grinded in," to use a common phrase, the best plan is to apply liquor potassæ for a moment, then plunge the hands in soft warm water, and use a stiff brush. This must be done with due foresight and care, however, to avoid making painful sores. The best plan is to apply it several times, very much diluted to the backs of the fingers and around the nails. The palm surface will stand much stronger applications.—National Druggist.

Violet Water.—

1. Spirit ionone, 10 per cent	½	dram.
Distilled water	5	fl. ounces.
Orange flower water	1	" "
Rose water	1	" "
Cologne spirit	8	" "

Add the spirit of ionone to the alcohol and then add the waters. Let stand and filter.

2. Violet extract	2	ounces.
Cassie extract	1	"
Spirit of rose	½	"
Tincture of orris	½	"
Green coloring, a sufficiency		
Alcohol, to	20	"
3. Tincture of orris	64	ounces.
Tincture of vanillin	16	"
Oil sandalwood	½	"
Oil bergamot	1	"
Oil rose geranium	½	"
Cologne spirit	80	"
Rose water	96	"

Dissolve the oils in the spirit; add the tinctures, and set aside for 3 days; then add the water slowly, stirring well, and let stand for 2 weeks before filtering. Color with chlorophyl or aniline green to the tint required.—Pharmaceutical Era.

Library Paste.—1. Dissolve 2 drams of alum in a quart of water and add flour sufficient to make a thick cream. Powder together 10 cloves and 1 dram of rosin and stir the powder into the cream. Put on the fire in a vessel of sufficient size 4 ounces of water and bring to a boil. When in active ebullition pour into the vessel the mixture of flour, etc., in a thin stream, stirring all the time to prevent burning. Pour into an earthenware vessel, cover tightly and keep in a cool place. This paste keeps well. When needed for use take out a portion and replace cover on container. If needed, thin down with boiling water.

2. Rice starch	2	ounces.
Gelatin	6	drams.
Water	16	fl. ounces.
Oil of cloves	15	minims.

Incorporate the starch powder with the water, add the gelatin and heat gently over a water-bath until a jelly-like compound results.

3. Best Bermuda arrowroot	1¾	ounces.
Sheet gelatin or best Russian glue	80	grains.
Water	15	ounces.
Methylated spirit	1	"

Put the arrowroot into a small pan, add 1 ounce water and mix it thoroughly up with a spoon, or the ordinary mounting brush, until it is like thick cream; then add 14 ounces water and the gelatin broken into fragments. Boil for four or five minutes, set it aside until partially cold, then add the methylated spirit and six drops of carbolic acid. Be very particular to add the spirit in a gentle stream, stirring rapidly all the time. Keep the paste in a corked stock bottle and take out as much as may be required for the time, and work it up nicely with the brush.—Pharm. Era.

Non-Poisonous Eggs of Pharaoh's Serpent.—

Try the following:

Potassium dichromate	2	parts.
Potassium nitrate	1	"
Granulated sugar	3	"
Peru balsam, q. s.		
Tragacanth mucilage, q. s.		

Powder the solid ingredients, add enough balsam to perfume, and make into pellets of the desired size.—National Druggist.

New Toilet Waters.—The Journal de la Parfumerie et Savonnierie Française gives the following new toilet waters:

HONEY WATER.

Oil of bergamot	12	drops.
Oil of lemon	12	"
Oil of neroli	5	"
Rose water	10	ounces.
Alcohol	22	"

Dissolve the oils in the alcohol and add the rose water.

ROSE TOILET VINEGAR.

Rose leaves, dry	112	parts.
Triple rose extract	280	"
Acetic acid	140	"
Distilled water	980	"

Mix. Let macerate for fourteen days, then filter.—National Druggist.

Silver Polish.—

Jeweler's rouge	1	ounce.
Tripoli	1	"
Sodium hyposulfite	2	"
Prepared chalk	8	"

Apply with a wet rag and polish off with chamois leather.—Western Druggist.

Tablet Glue.—The following is said to yield a good glue for padding paper:

Glue	4	pounds.
Glycerin	2	"
Linseed oil	½	"
Sugar	¼	"
Aniline dye, enough.		

After softening the glue in a little water heat it with the glycerin and sugar, and when dissolved add the aniline and stir in the oil. Use hot.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Enterprise in Italy.—Consul Weingartner sends from Catania, under date of December 20, 1899, translation of a newspaper article on German interests, in Italy. The Germans, it says, have taken possession of half of the traffic of the principal seaports. At Genoa, the business in grain and wine is almost entirely in their hands, and they are making progress in cotton and in artificial fertilizers. The navigation society "La Veloce," while apparently in Italian hands, is managed by Germans. They have taken advantage of the industrial protection inaugurated by Italy in 1878, and re-enforced in 1887. Their capital is invested in factories for cotton spinning, for velvet making, for the manufacture of carburet of calcium, and of late, for sugar making. The electric trams at Genoa, Florence, Bologna, Alexandria, Perugia, Cuneo, etc., as well as the lines about to be opened between Brodighera and San Remo, between Lecco and Chiavenna, between Oneglia and Porto Maurizio, are owned by four or five very powerful firms—Siemens & Håske, Sckukert & Ganz, the Nuremberg Electrizitats Gesellschaft, and the Continentale Gesellschaft. The Norddeutscher Lloyd, the Hamburg American, and the Kosmos lines call at Italian ports. The perforation of the Simplon from the Italian side is undertaken by the German firm of Brandt, Brauman & Co., while Major Donath has a project now before the Italian government to dry up the marshes of the Roman campagna. These undertakings find support in the powerful banks, branches of which are found everywhere. These are an important factor in the industrial expansion of Germany.

Lighting of Indian Cities.—In reply to an inquiry from an Ohio firm, Consul Fee, of Bombay, on December 7, 1899, says:

The use of electricity as power and light is yet in its earliest stages in India, Madras being the only city using it as a motive power for street cars. Bombay is poorly lighted by gas, and her tramway is run by horse power. This company has its main office in New York city, and the stock is owned principally in the United States. It has applied to the Bombay municipality for the privilege of converting its motive power to electricity. This will undoubtedly occasion other electric improvements. Electric lights are used in a limited way in the better class of residences and bungalows. Bombay is the best place in which to locate an agency. It is not only great in population (having over 821,000), but also in wealth and trade. One-third of all the exports from the United States to India come to this port. The systems of Indian railways as well as the steamship lines center here. The bulk of electric supplies now come from Europe. The United States during the past few years has been pushing her trade in this line, and the late steamers have had noticeable shipments of these supplies from New York.

Scarcity of Coal in Italy.—Ambassador Draper transmits from Rome, under date of January 11, 1900, translation of an article which appeared in L'Italie of even date, as follows:

"The increase in the price of coal in England threatens to have serious consequences in Italy. It is known that English dealers have taken advantage of the present war to maintain and increase the price of coal, which has now become even in England a luxury, and has reached in certain towns the price of 45 francs ($8.69) per ton.

"Moreover, it is known that means of transport are becoming insufficient, the English government having hired a large number of boats belonging to companies and to private individuals. The result of it is that coal may very soon reach the price of 50 francs ($9.65) per ton in Genoa and 60 francs ($11.58) in Milan. We are to-day informed that, owing to the lack of coal, eight industrial establishments of Bovisa may be obliged to shut down. Thousands of workman would thus be thrown out of work. The proprietors of these establishments have requested Signor Lacava (Minister of Public Works) to secure the prompt assistance of the government at a time when, owing to the industrial revival witnessed in Italy, a cessation of work would have disastrous consequences.

"We understand that the Minister of Public Works is studying the best means to prevent such a crisis and to insure public enterprises and at the same time assist private ones."

The ambassador adds:

The situation, I think, is worthy the attention of coal-mining enterprises in the United States. Italy depends mainly upon England for coal, and the price to the consumer is always high, even in times of peace; now, it has gone up enormously. In view of these facts—the Italian high prices, the low cost per ton of American coal at the seaboard, and the ocean freight rates—it appears to me that a large margin of profit is offered to American coal exporters.

I may add that some exporters in England deem it wise, when they fill an order for Italy, to insist upon payment upon delivery of invoices; otherwise, vexatious objections are apt to be made, and the cargo may be disposed of at a disadvantage.

Railway in Shantung.—Ambassador White sends from Berlin, January 4, 1900, copy of an official publication dealing with the development of the Kyaochau district, from which the following extract is taken:

On the 1st of June, 1899, the concession for the construction and management of a railway from Tsingtau via Wei hsien to Isi nan fu, the provincial metropolis of Shantung, with a branch line to Po shan was granted by the chancellor of the empire to a syndicate representing a wide circle of German industries and mercantile interests.

This company was organized about the 14th of June, 1899, as the Shantung Railway Company, with headquarters in Berlin. The removal of the headquarters to Tsingtau, conformably to the terms of concession, is already in progress. The company has a ground capital of $12,852,000, of which $3,213,000 has already been deposited. The company has pledged itself to build and put in operation the road within five years and the extension line from Tsingtau to Wei hsien within a period of three years. The united length of these roads will be about 280 miles—the branch line Tsingtau-Wei hsein, 112 miles.

By the establishment of these roads, the great coal districts in the north of the province of Shantung will be united in a practical way with the important districts between Tsingtau and Isi nan fu. The road is to be the normal gage—1·5 yards. The foundation work is already provided for a double track.

Supplementary to the expenditures of the government for the harbor works in Kyao-chau Bay and for the general expenses of the administration, the company has agreed to the payment of a tax from the profits of the enterprise in proportion as the annual dividends shall exceed the sum total by 5 per cent. The German government reserves the right to acquire possession of the railway at a suitable price at the expiration of sixty years. The terms for the construction and management are such as to secure to the German Government the operative right of control; but, at the same time, free action for the execution of the enterprise is guaranteed to the company.

Preliminary work has been begun in Germany as well as in China. The delivery of the superstructure materials for the entire railway, the contracts for the delivery and setting up of bridges, as well as for the requisite transportation of locomotives, passenger, freight and coal cars, have been given to German enterprises by the Berlin division of the company. The stock already contracted for approximates in weight to 85,000 tons and in value to about $4,760,000. Contracts for the shipment of this material to Tsingtau have been made with German steamship companies. The first delivery of tires, sleepers, rails and small iron tools to the weight of 4,300 tons was shipped during December, 1899, for an extension of 15½ miles. The Chinese government has conceded to the free import of all railway materials and rolling stock.

A board of directors, with competent staff, for the construction and management of the road has been established at Tsingtau. Preliminary studies were made as early as September, 1899. This vigorous beginning of the work leads to the expectation that the entire extension will be completed within the fixed time, and railroad connection between the important coal districts of Wei hsien and Po shan and the German ports will be accomplished.

Agricultural Implements in India.—In reply to inquiries by an Illinois firm, Consul Fee, of Bombay, under date of December 13, 1899, says:

The population of India is about four times that of the United States, while the latter has about double the area of the former. As the bulk of the people are employed in agricultural pursuits, it is obvious that those parts of India capable of cultivation must be divided into small farms. Each man rents, generally, but a few acres. There are, of course, occasional large plantations run by a rich man or rajah, but these are exceptional. The ancient plow, costing perhaps 50 or 75 cents, pulled by oxen, is used. Few implements are employed. The mamooties—a kind of a mattock, more like a carpenter's adz, with a wider blade—are universally used for all manner of work in the ground. Natives will not use the wheelbarrow or the shovel. Women carry dirt, mortar, brick, and in fact everything in baskets on their heads.

On account of the famine of 1896-97, and again this year in Western India, the country people are not able to buy. Besides, there seems to be a disinclination to adopt new methods, making easier the daily burden. A short time since, a large agricultural-implement firm of England sent a steam-plow and men to exhibit it in India. They took it all over the country and at a great expense gave practical exhibitions and instructions. I am reliably informed that the did not secure a single order. I cite this as an example of the native indifference to improvements.

Just now, there is considerable talk in local papers on the question of drilling deep wells for water in the famine districts of India. Here is a chance for an American firm to do some business.

New Spanish Tariff.—I wish to call the attention of our exporters to the increased duties on a number of articles now exported from the United States to this country, as provided for in the new Spanish tariff which went into effect on January 1, 1900, says Consul General J. G. Lay, of Barcelona. These increased duties will seriously affect our exports of typewriters and, especially, oils.

Typewriters in Spain are considered at present a luxury, and not a necessity, among business men; and although in time manufacturers, lawyers, and others will use them, still, of course, if the price is increased, so also will be the difficulty in introducing them, as none are made in this country. According to the new Spanish tariff, typewriters, which formerly paid (No. 268 of the old tariff) 24 pesetas per 100 kilogrammes plus 20 per cent. war tax, or 29 pesetas per 100 kilogrammes (says, at current exchange, less than 2 cents per pound weight) are now dutiable at 280 new tariff) 8 pesetas per kilogramme (not per 100 kilogrammes, as in the old tariff) plus 20 per cent. war tax—0·6 pesetas per kilogramme, or at current exchange over 64 cents per pound weight, or about thirty-two times as much as before. It must be noticed, however, that the old tariff was on the gross weight, whereas the new tariff charges on the net weight; so as it may be fairly reckoned that the packing of a typewriter weighs about as much as the machine itself, the difference is really only sixteen times as much. An ordinary typewriter weighs from 20 to 30 pounds with its cover and the accessories usually supplied with it, so that the duty on a first-class American typewriter is now, say, from $13 to $20, whereas before it averaged about half a dollar per machine.

Another item in the new Spanish tariff covers phonographs and their parts, which formerly were not enumerated in the Spanish tariff, but are now dutiable the same as typewriters (No. 290 new tariff)—64 cents per pound weight.

Every description of electrical, scientific and office labor-saving apparatus or instrument is now also classed under a heavy rate (Nos. 291, 292, 292, and 294 new tariff) plus 20 per cent. war tax. For instance, an Edison mumograph, which formerly paid $1.45 is now dutiable at $4.

The duties on sewing machines, velocipedes, staves, and lumber remain unchanged.

The new tariff has doubled the duty previously charged on paraffin wax; this wax imported from the United States is now dutiable at 48 pesetas per 100 kilogrammes gross weight, plus 20 per cent. war tax, or 57·60 pesetas ($8.46 per 220·46 pounds), and from Great Britain, at 40 pesetas ($5.88), or a difference of 17·60 pesetas ($2.58) per 220·46 pounds. I understand from our agents here of oil and paraffin concerns in the United States that this increase makes business impossible in Spain. Their clients, who have made important contracts, have decided not to import more wax, and New York firms have been called to stop all shipments. Should the Spanish government offer to reduce the duty to 40 pesetas per 100 kilogrammes (220·46 pounds) gross weight, the same duty as is now paid on British wax, it would still be too high to compete with stearin, which pays only 24 pesetas ($3.52) per 100 kilogrammes and 20 per cent. war tax. The various candle makers who have contracts with British manufacturers have also been obliged to give instructions to stop all shipments, as even the British paraffin cannot be introduced and pay the 40 pesetas per 100 kilogrammes duty.

The Barcelona candle makers have decided to send a commission to Madrid to protest against the increased duties on paraffin. It would appear that the increase in the duty was made in favor of the stearin manufacturers, who pay 1 peseta (14.7 cents) per 100 kilogrammes gross weight on tallow which is used for the manufacture of stearin.

Lubricating oils from the United States under the new tariff are dutiable at 60 pesetas ($8.82) per 100 kilogrammes (220·46 pounds) net and 13 pesetas ($1.91) per 100 kilogrammes for barrel and 20 per cent. additional war tax, while those from Russia and Great Britain are now dutiable at 50 pesetas ($7.35) per 100 kilogrammes net and 10 pesetas ($1.47) per 100 kilogrammes for barrel, without war tax. Prior to January 1, 1900, the duty on lubricating oils from the United States was 30 pesetas ($4.41) per 100 kilogrammes gross weight, with 20 per cent. additional war tax, while the British and Russian oils paid 30 pesetas per 100 kilogrammes gross without any war tax. It is an advantage to our exporters to pay duty on the net, instead of the gross, weight of the oil, but the increased duty of 30 pesetas per 100 kilogrammes will entirely stop all importations of lubricating oils from the United States and seriously interfere with those of cylinder oils; and even if the duty should be reduced to that now paid on British and Russian oils, we cannot compete with the vegetable oils.

Trade in Cape Colony.—While American trade in South Africa during the last three months has been excellent, as evidenced by the receipts of foodstuffs, mules, horses, etc., yet I regret, says Consul J. G. Stowe, of Cape Town, that the United States is not having a larger share in the exports hither of such manufactured articles as bottled beer and spirits, clothing, hose, cloth, harness, saddles, electrical field outfits, wagons, telegraphic material, traction engines, steam plows, wagon material, boots and shoes, iron, steel bridge work, military cycles, etc. Large orders for locomotives and rolling stock have been replaced. While the war is in its earlier stages, and the rebate trade with the Boer States is nil, diminishing the volume of trade, a very large business is still being done in certain lines; and the goods of all sorts taken by the Boer armies from the British colonies will have to be replaced. A demand for United States goods must come when the war is over.

The mine owners of the Transvaal are not idle, but have their engineers and draftsmen at work preparing plans; and orders are being placed somewhere for mining machinery and plants to replace what may be destroyed or injured, and in anticipation of new operations and increased business. Many new plants are lying at seaports, stopped in transit. The coast cities are preparing their docks, now inadequate and crowded beyond their capacity, for the great influx of goods when the strike is over. Cape Bay is crowded with vessels; as many as eighty to ninety have been counted at one time.

I desire to impress upon American manufacturers the necessity of earnest effort and prompt shipments to gain this trade. It is to be regretted that orders are being refused or accepted and held back by American manufacturers in the fear of nonpayment. Such action may seriously affect future business. If they are unable to fill orders, they should not hesitate to say so; but they should not accept and fail to ship. The seaport cities are benefiting by the war; the demand for cattle, sheep, vegetables, and forage is such that, with the advance in prices, the agriculturists are prospering. In fact, excepting in the besieged cities, the colonies, so far as trade is concerned, are thriving.

I note that a demand for bakers' ovens and appliances may arise, as bakers' licenses in the colony have been abolished. A New York firm has a nice article in the line of ovens for small bakeries on display. The demand for furniture even now is good, the refugees from the Transvaal preparing houses, it would seem, for a protracted stay. As lumber has advanced 25 per cent. and other articles in proportion, furniture is expensive.

Tenders for bridge work, electrical and railway material, and machinery are open for bids. Large shipments of fire-extinguishing apparatus from London are arriving, on war account, for hand engines and to put out fire caused by shells. East London has recently built an electric-light plant and an electric tramway, using Babcock & Wilcox boilers and other American appliances. The imports of electrical materials for October exceeded the corresponding month of 1898 by $30,000.

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No. 660. February 21.—Building in Siam—*Reform of the Swedish Consular Service—*Working of German Law on Exchange Speculation—*Duty on Mining Machinery for the Klondike.

No. 661. February 23.—Demand for American Coal in France—Cycle Trade of the United Kingdom—French Coal Strike Ended.

No. 662. February 24.—Coke Ovens in Belgium and Australia—Proposed Shipyard in Venice—Scarcity of Corn in Veracruz.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

WORKING DRAWINGS OF AN ELECTRIC CAB.

THE working drawings are those of a cab suitable for summer use, and are especially intended to illustrate the design of the side elevation, together with the position of the different mechanical features which belong more particularly to an electric-motor carriage.

The design is the representation of an idea which we have published for the benefit and information of our many readers. To provide for these new designs, it was necessary to cut loose from the prevailing idea of the arrangement of this class of motor-electric, and proceed by another path to bring the work up to that standard of high-class carriage building which the vehicle as a mode of travel deserves, and to make it a pleasure carriage rather than a machine or engine. The effect of beauty is the predominating force which influences the carriage maker; that other factor, strength, will in the meantime assert itself.

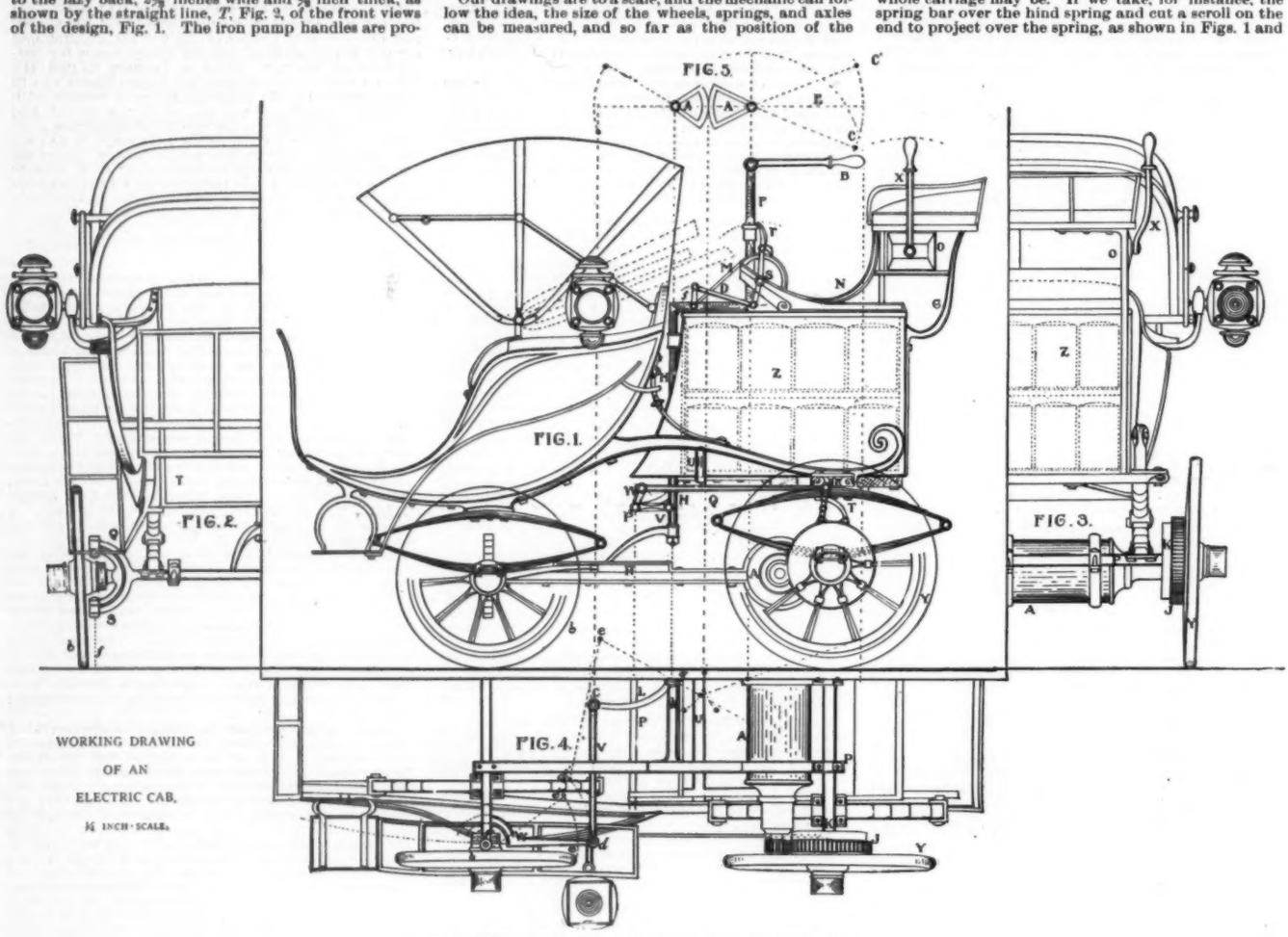
The length of the cab is 9 feet 4 inches; the height is 7 feet; the width is 5 feet 4 inches. The body is mounted on iron pump handles bolted to the four elliptic springs, the pump handles bolted to the rocker of the body. The rockers are reinforced with an iron edge plate, screwed to the inside surface from the dash to the lazy back, 2¼ inches wide and ¼ inch thick, as shown by the straight line, *T*, Fig. 2, of the front views of the design, Fig. 1. The iron pump handles are provided with solid forged flaps, which rest on each elliptic, and secured by ⅜-inch bolts. The iron pump handles pass outside of the battery caisson, *Z*. The front end of this chest is supported by iron loops forged onto the pump handle, which pass under the rockers and floor, and are secured by T-bolts to the rocker. A bar of ash is let into the bottom, which in turn holds up the floor that the cells rest upon. This is the front bar of the three which compose the support for the floor of the battery trays, which are made of hard ash, and must be seasoned (kiln-dried). The top of the battery chest is made of dry birch, the grain of the wood running lengthwise of the box, composed of three pieces screwed onto the framing and covered with a paste of white lead and varnish, glue not being suitable for the fixing of the boards. The battery caisson is not fixed to the body; the space separating them is utilized for the passage of the steering and brake rods used in guiding and stopping the carriage. Upon the back end of the chest is mounted a driver's seat on iron braces, *G* and *N*, Fig. 1. The seat frame is provided with two compartments; on the near side is the controller, *O*, on the off side a box provides for a kit of tools, and the controller takes up the space of 18×7×5 inches. The handle-bar, *X*, Fig. 1, and, *X*, Fig. 3, operates machinery for starting, stopping and regulating the speed of the motor, *A*, Figs. 1, 3 and 4. By this means the electric current generated from the batteries, *Z*, is controlled by wires which connect the controller with the motor. The motor-shaft is operated upon the driving-wheel, *Y*, with a 2-inch cog meshing into a 14-inch toothed cog, *J*, clipped to the spokes of the driving-wheel, *Y*. The motor is fixed to the 2-inch rear axle by means of the perch plates, *I* and *R*, Figs. 4 and 1. The bottom plate forms the clip yoke, which receives the threaded stem forward on the top perch plate, shown by the letters, *P P*, Figs. 3 and 4. The inside nut is threaded to a ⅞-inch bolt. These plates hold the motor to the axle in rings. The other ends of the perch plates are likewise coupled to the front axle. The perch is made of hickory, the ends of which butt the axle at the front and the motor at the rear. The top plate of the perch is bridged to receive the steering bar, *V*, which is pivoted to the arm, *W*, at *d*, Fig. 4, and to the fork brace, *L*, at *C*. The movement is crosswise from, *d'* to *d'*, of the outside knuckle, and from *e e'*, of the inside knuckle joint. This distance is 10½ inches, this being necessary in order to obtain an angle to the rim of the front wheel, *b*, of 45 degrees, from *b* to *e'*, along the dotted line, *W*, Fig. 4. When the handle-bar, *B*, of the steering-gear, Fig. 1, is moved aside 7 inches from the center, *E*, Fig. 5, to *C'*, the bar, *L*, by means of the segments, *A A*, Fig. 5, will move to the point of the pivot, *g*, Fig. 4. When this handle-bar, *B*, is moved to the right the carriage will be turned to the left side, which result is expected by the driver, as all turns are made to the near side when the driver has the right of way. If we bridge the perch at *R*, Fig. 1, we increase the rigid support of the motor to the axle. The perch is stronger than it would be if the plate was an unbroken line.

Our drawings are to a scale, and the mechanic can follow the idea, the size of the wheels, springs, and axles can be measured, and so far as the position of the motor, the battery, the controller, the steering-gear and brake are concerned, they are the same as in nearly all electric propelled carriages; the shape of the motor may be different, but the method of turning the driving wheel, *Y*, is present in every case, and as a general thing the axles are coupled together with two or three perches, but this is not the only method used. Some are without rigid perches and some perches may be pivoted. The brake is as important to a motor carriage as the steering-gear, and the means of using it must be within convenient distance of the driver's right foot, it is therefore placed to the right of the upright steering rod, *F*, Fig. 1. The brake is shown in the side elevation, Fig. 1, and when set so as to clutch on the disc, *K*, impedes the turning of the driving-wheels. This clutch is therefore constructed on both driving-wheels alike; the lever *r*, Fig. 1, is pushed with the foot ahead. This lever is pivoted at *S*, and connected to the rod, *D*, which is pivoted to the the upright rod *f*, then from this point a flat rod, ⅞ inch thick by ⅞ inch wide, is connected to the 1-inch round cross rod, *P*. Fig. 4, and shown at *P*, Fig. 1, as pivoted at *V*, Fig. 1. Then the flat bar, *Q*, in pivoted at *W'* to the cross rod, *P'*, which at the back end is pivoted to the clutch, *T*, which finally is pivoted to a band of brass fixed to the axle, hinged in two parts and separated when the brake is off with a spring, which keeps the band from contact with the edge of the revolving disc, *K*, fixed to the cog-wheel, *J*. We have seen brakes fixed in this way, but do not endorse them. We think it better to fix the support of the brake clutch lower down and make the supporting braces fast to the end of the motor, in close proximity to the disc, *K*.

The drawing shows a step, with a wing at its rear over the front wheel, which makes a convenient entrance, especially from the sidewalk. It is about 7 inches high; in riding the passenger can see ahead, which is an important advantage in favor of this design, and the suggestion is offered that for park and seaside resorts the design is an appropriate one. The line, *M*, Fig. 1, is the slope which the top of the box has that covers up the cogs and rods connected with the brake and steering-gear, but left exposed on the draught to enable us to show the construction of the pivots, the rods and the connections.

H is a bar that braces the perches crosswise; it may be bolted to the plates or welded on; the latter occasions the most work, but has by far the best appearance, and for this, if for no other reason, it should be welded, and if we resort to smooth forgings all the way through the appearance of the finished carriage will repay the extra expense. To leave the ends of the bars, either wood or iron, unfinished, will prove in the end more expensive than to round or chamfer them, or to finish with scroll finish in regular carriage form. This last is the best that can be devised, and then the painter can stripe them and the appearance cannot be adversely criticized. The clumsy appearance of the motor carriages has done much to injure them. If carefully designed at the outset, they can be made to look light and graceful, no matter how heavy the whole carriage may be. If we take, for instance, the spring bar over the hind spring and cut a scroll on the end to project over the spring, as shown in Figs. 1 and 3, and let the flap of the pump handle extend out upon it, with the edges of the iron rounded off, we will have a good looking piece of work. We must secure the top, or the back end of the wing to the body, or to some other support in that vicinity, and the shortest distance to the point of fixture is generally the one selected for this purpose. We fix the stay of the wing to the brace, *H'*, and bolt this to the pump handle and the body, and solid to this brace, *H*. We turn off the stay to take the bottom of the wing, which is bolted. The bolts are first put in through the square hole in the iron of the wing and driven in so as to make a tight fit, the head being countersunk so as not to show on the top of the leather when filed up in good shape. It makes a good job, and one that is not expensive. The work will look as though it was intended to be so, but, on the other hand, if we put the matter off until the job is ironed, and as a last thing begin to calculate where and how to fasten it on, then the trouble and expense will begin and a nice piece of iron work will be spoiled, because of the bolt being just where it can be seen. These small things look well; they are noticeable more than the axles, and they can be turned to add much to the appearance of the work. The point to keep in sight is to work in the regular carriage making way, or better, but not worse. If there is a machinist who can iron off a motor carriage better than the carriage smith irons off his victoria or brougham, then he can iron anything from a locomotive to a sulky, and this includes all that is heavy or light.

The foregoing remarks on the iron and wood work of the motor carriage are suggested by what we have seen, and they are intended to improve the construc-



WORKING DRAWINGS OF AN ELECTRIC CAB.

tion of the carriages in this country. They are already strong enough, they are already heavy enough, and they are big enough, but the work is crudely done. It is rough, it is not symmetrical, the irons do not taper, are not correctly swaged, the offsets are not carefully executed, and the setting of the axles is contrary to those rules long established for the construction of the dished wheel and tapered arm. If we dish the wheel we must plumb the spoke, and if we plumb the spoke we must taper the spindle. We cannot do one without doing the other two, for if we desire to avoid the friction of the box and axle we must have the spindle parallel to the ground, and if the spindle is not horizontally set, then the box will crowd either the nut or collar. If we do not dish the wheel it will not stand up for its expected time. The wheels look better when flared out at the top, as shown on the drawings. There is no mechanical problem in the fact that the wheels are driven by a cog-wheel that is clipped to the spokes, as in casting this toothed wheel the angle which the flare of the wheel creates can be made upon the pattern. Any mechanic will admit it is of no consequence what this angle may be. The teeth of the cog-wheel, *J*, can be set to the flare of the wheel, called in the carriage shop the swing of the wheel, and mesh with the one fixed to the shaft of the motor. This will be done as time is given to the work. We know that the front and hind wheels are set to a vertical instead of an inclined plane, and the result is that the wheels appear to lean in at the top, and if set to a vertical line the weight which they carry will spring a 2¼-inch axle, so that the axle will off at the top of the collar and on at the bottom of the point of the spindle. These are the facts, and the best mechanic in America cannot change them. Every carriage maker knows this to be true, and this applies to any wheel that has a tapered spindle. It is impossible to taper a spindle and then use a straight or vertical rim, and prevent the above trouble.—We are indebted to our esteemed contemporary The Hub for this interesting description.

THE INDUSTRIAL PRODUCTION OF OZONE.

BUNSEN, Fremy, Andrews, and many other illustrious scientists who were contemporaries of the discovery of nascent gas, predicted for it a most brilliant future.

"There is no discovery in modern chemistry," wrote Fremy, "that is more important than that of ozone."

"When we shall be able to produce it industrially," added Bunsen, "hundreds of new applications will arise."

Unfortunately, although it was easy in laboratories to have apparatus that furnished a few milligrammes or even a few grammes of ozone, apparatus capable of producing large quantities of it industrially were more difficult of construction.

Ozone, which is, as well known, merely polymerized oxygen, endowed with extremely energetic properties, is produced in a very large number of reactions; but the simplest method of obtaining it is undoubtedly to submit pure oxygen or the oxygen contained in the air to electric discharges of high tension.

Most of the apparatus for producing ozone are characterized by the fact that an insulating plate forming a dielectric is interposed between the conducting electrodes at which end the two wires that lead the current.

The object of the dielectric is to render the production of the silent discharges regular. But it presents to the passage of the electricity a resistance which is not to be disregarded; and, moreover, since we usually employ glass, the extreme fragility of the latter renders the handling of the apparatus an extremely delicate matter.

Electric discharges of high tension may exhibit themselves in several absolutely different manners. We suppose here a case of a powerful electric source capable of giving rise to intense calorific phenomena.

In Fig. 1, we show the different aspects that the phenomena assumes when the poles of a high-tension transformer are connected on the one hand with a point and on the other with a plane conducting plate.

When the difference of potential reaches the desired degree, we see the point become slightly illuminated (Fig. 1, No. 1). A pencil of violaceous light of conical form spreads out upon the plane surface situated opposite the point. If the tension slightly increases, the phenomenon changes aspect quite abruptly (Fig. 1, No. 3), the pencil condensing into a clearly defined line of white light. A few volts more, and the arc appears (Fig. 1, No. 3) with its characteristic whistling and its large flame of a yellowish white, which escapes from the point and licks the walls of the opposite electrode with a thousand odd contortions.

When it is desired to produce ozone, it is necessary to depend upon the first phase of the phenomenon. In the two other cases, not only do we not reach the object in view, but the apparatus used are put rapidly out of service.

If we have to do with an ozonizer having a dielectric, the latter will be pierced and reduced to fragments, and the metal that it protects will be melted (Fig. 1, No. 4).

If the dielectric be suppressed, the effects produced will be none the less disastrous, since the metal may melt, and if precautions be not taken quickly enough, the short circuit produced may assume extremely dangerous proportions, as well for the ozonizing apparatus as for the electric generators that supply it.

Things were in this state when it occurred to M. Otto to establish rotary ozonizers. Desiring to form truly industrial apparatus, he in the first place suppressed the dielectrics that he had used in a first series of researches. In order to prevent the formation of arcs or dangerous short circuits, especially with the enormous quantities of energy that enter into play in the ozone works, M. Otto, instead of leaving the electrodes constantly opposite each other, displaces one with respect to the other. This movement, whatever be its nature, has a double purpose. It prevents the formation of arcs in a large measure, and in case the latter do form, or dangerous short circuits have a tendency to occur, there is an immediate, certain, and automatic action that averts all danger.

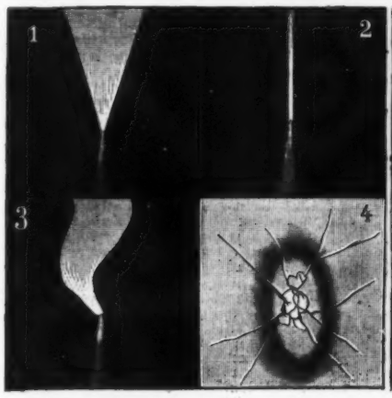


FIG. 1.—1. SILENT DISCHARGE. 2. SPARK. 3. ARC. 4. DIELECTRIC BROKEN BY A SHORT CIRCUIT.

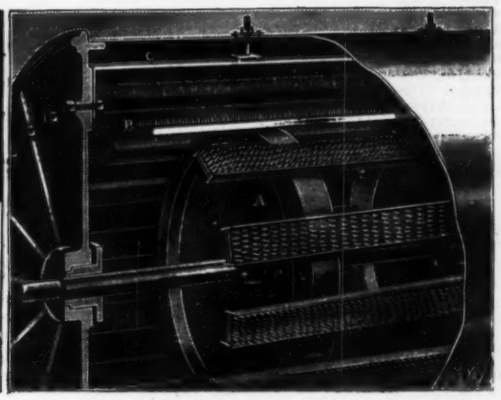


FIG. 2.—INTERIOR VIEW OF AN OTTO ROTARY OZONIZER.
Diameter, 6¼ feet.

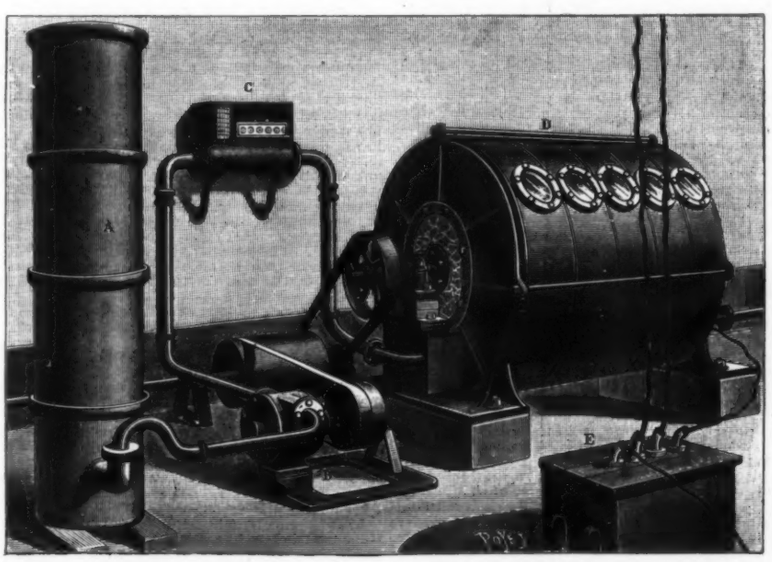


FIG. 3.—INSTALLATION OF A ROTARY OZONIZER AT THE WORKS OF THE OZONE COMPANY AT PARIS.

We evidently have here the simplest and surest method that can be employed.

The inventor has studied many other forms of the process, but they all present, in different degrees, inconveniences that have caused them to be rejected.

In Fig. 2, we show one of the methods of practically applying the process that M. Otto has finally adopted and that we have seen in use in his works at Auteuil. A movable cylinder, *A*, provided with a series of bars, *B*, parallel with the axis, moves in the interior of a steel-plate cylinder lined with plates, *C*, parallel with the bars. Every time that a movable sector passes in front of a stationary one, powerful silent discharges occur and large quantities of ozone are produced.

If, for any reason whatever, a short circuit occurs, it is immediately interrupted.

The principle of movable electrodes lends itself to an almost infinite variety of applications. Thus, instead of utilizing two concentric cylinders, we may employ a series of parallel rings mounted upon the same axis and moving between other rings upon which are arranged fixed sectors. It is an apparatus of this nature that is represented in Fig. 3, which gives a general view of an installation for the industrial production of ozone.

The air, purified and dried by its passage through a column, *A*, filled with pumice stone saturated with sulphuric acid, is sucked up by a pump, *B*, and forced into a registering meter, *C*, and sent to the ozonizer, *D*, that is supplied by the high-tension transformer, *E*.

The meter employed is specially constructed for the measurement of very large discharges of gas.

Everything is new in this ozone industry, and it was necessary, as at the beginning of electric lighting, to devise, along with generators properly so-called, all the indispensable accessories that permit of a practical application of the process in the industrial domain.

Thanks to the new apparatus, the applications of ozone that have been made up to the present, with some difficulty, are to become thoroughly practical. As for those more closely connected with the large industries, such as the sterilization of potable water, the treatment of alcohol, the bleaching of fabrics, the creation of a septic air in hospitals, the aeration of ships, and many others, they are going to enter a new path.

For the above particulars and the illustrations we are indebted to La Nature.

PICTURES PRODUCED ON PHOTOGRAPHIC PLATES IN THE DARK.*

By WILLIAM JAMES RUSSELL, Ph.D.

I THINK I may fairly assume that every one in this theater has had their photograph taken, and consequently must have some idea of the nature of the process employed. I have, therefore, only to add, with regard to what is not visible in the process of taking the picture, that the photographic plate is a piece of glass or such like body, coated on one side by an adhesive paste which is acted on by light, and acted on in a very remarkable manner. No visible change is produced, and the picture might remain latent for years, but place this acted-on plate in a solution of, say, pyrogallol, and the picture appears. The subsequent treatment of the plate with sodium hyposulphite is for another purpose, simply to prevent the continuance of the action when the plate is brought into the light. Now, what I purpose demonstrating to you to-night is that there are other ways of producing pictures on photographic plates than by acting on them by light, and that by these other means a latent picture is formed, which is rendered visible in precisely the same way as the light pictures are.

The substances which produce on a photographic plate these results so strongly resembling those produced by light are, some of them, metallic, while others are of vegetable origin. At first it seemed very remarkable that bodies so different in character should act in the same way on the photographic plate. The following metals, magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth, tin, cobalt, antimony, are all capable of acting on a photographic plate; magnesium most strongly, antimony but feebly, and other metals can also act in the same way, but only to a very slight extent. The action in general is much slower than that of light, but under favorable conditions a picture may be produced in two or three seconds.

Zinc is nearly as active as magnesium or cadmium, and is the most convenient metal to experiment with. In its ordinary dull state it is without the power of acting on a photographic plate, but scratch it or scrape it, and it is easy to prove that the bright metal is active. I would say that all the pictures which I have to show you, by means of the lantern, are produced by the direct action of the metal, or whatever the active body may be, on the photographic plate, and that they have not been intensified or touched up in any way. . . . Here is a piece of dull zinc on which some circles have been turned. It was exposed to the photographic plate for four hours at a temperature of 55° C. In the other cases, which are on a

* A lecture delivered at the Royal Institution of Great Britain and printed in The Chemical News.

larger scale, a zinc stencil was polished and laid upon a photographic plate, and you see where the zinc was in contact with the plate such action has occurred. In another case a bright zinc plate was used, and a Japanese stencil interposed between it and the photographic plate, and a very strong and sharp picture is the result. The time required to produce these zinc pictures varies very much with the temperature. At ordinary temperature the exposure would have to be for about two days, but if the temperature was, say, 55° C., then one-half to three-quarters of an hour might be sufficient. Temperatures higher than this cannot be used except for very short times, as the photographic plate would be damaged. Contact between the zinc and photographic plate is not necessary, as the action readily takes place through considerable distances. Obviously, however, as you increase the distance between object and plate, so you decrease the sharpness of the picture. . . . Many alloys, such as pewter, fusible metal, brass, etc., are active bodies, and in the case of brass the amount of action which occurs is determined by the amount of zinc present. Thus you will see that a brass with thirty per cent. of zinc produces hardly any action on the photographic plate, but when fifty per cent. of zinc is present there is a fairly dark picture, and when as much as seventy per cent. is present, a still darker picture is produced.

The second class of bodies which act in the same way on a photographic plate are organic substances, and belong essentially to the groups of bodies known as terpenes. In trying to stop the action of metallic zinc, which I thought at the time might arise from vapor given off by the metal, copal varnish was used, but in place of stopping the action it was found to increase it, and this increase of activity was traced to the turpentine contained in the varnish. In experimenting with liquids, it is convenient to use small, shallow circular glass vessels, such as are made for bacteriological experiments, the plate resting on the top of the vessel and the amount of liquid in the vessel determining the distance through which the action shall take place. The following slide, produced in this way, shows how dark a picture ordinary turpentine produces. All the terpenes are active bodies. Dipentine is remarkably so; in a very short time it gives a black picture, and if the action be continued, the dark picture passes away, and you then have a phenomenon corresponding to what photographers call reversal. The strong-smelling bodies known as essential oils, such as oil of bergamot, oil of lavender, oil of peppermint, oil of lemon, etc., are all active bodies, and all are known to contain in varying quantities different terpenes; therefore, ordinary scents are active bodies, and this is shown by the following pictures produced by eau de cologne, by cinnamon, by coffee, and by tea. Certain wines also act in the same way: Sauterne gives a tolerably dark picture, but brandy only a faint one. Other oils than these essential ones are also active bodies; linseed oil is especially so; olive oil is active, but not nearly as much so as is linseed oil; and mineral oils, such as paraffin oil, are without action on the photographic plate.

Interesting results are obtained with bodies which contain some of these active substances; for instance, wood will give its own picture. . . . Again, the next slide you will recognize as the picture of a peacock's feather. There is much interest in these pictures of feathers, as they distinguish the brilliant interference colors from those produced by certain pigments; the beautiful blue in the eye of the peacock's feather is without action on the photographic plate. Butterflies' wings, at least some of them, will draw, as you see, their own pictures. Linseed oil, which is a constituent of all printing ink, makes it an active body, and it can, like the zinc and other active bodies, act through considerable distances. . . .

An interesting and important peculiarity of all these actions is that it is able to pass through certain media; for instance, through a thin sheet of gelatin. Here are two plates of zinc; both have been scratched by sandpaper; one is laid directly on the photographic plate, and the other one has a sheet of gelatin, its color is of no note, laid between it and the sensitive plate; the picture in this case is, of course, not so sharp as when no gelatin is present, but it is a good and clear likeness of the scratches.

Celluloid is also a body which allows the action to pass through it, as is seen in this picture of a piece of perforated zinc, a picture which was produced at ordinary temperatures. Goldbeater's skin, albumen, collodion, gutta-percha, are also bodies which are transparent to the action of the zinc and the other active bodies. On the other hand, many bodies do not allow the transmission of the action through them; for instance, paraffin does not, and among common substances writing ink does not, as is easily shown by placing ordinary paper with writing on it between the active body and the photographic plate. The active body may conveniently be either a plate of zinc or a card painted with copal varnish and allowed to dry, or a dish of drying oil. The picture of an ordinarily directed envelope shows this opacity of ink well. It is a property long retained by the ink, as this picture of the direction of a letter, written in 1801, shows; also this letter of Dr. Priestley's, dated 1795; and here is also some very faded writing of 1810, which still gives a very good and clear picture. Even if the writing be on parchment, the action passes through the parchment, but not through the ink, and hence a picture is formed.

With bodies which are porous, such as most papers, for instance, the action passes gradually through the interstices, and impresses the plate with a picture of the general structure of the intervening substance. For instance, the following pictures show the structure and the water-mark of certain old and modern writing papers. Some modern writing papers are, however, quite opaque; but usually paper allows the action to take place through it, and combining this fact with the fact of strong activity of the printing ink, the apparently confused appearance produced on obtaining a picture from paper with printing on both sides is accounted for, as the printing on the side away from the photographic plate, as well as that next to it, prints through the paper, and is, of course, reversed.

I hope I have now given you a clear idea how a picture can be produced on a photographic plate in the dark, and the general character and appearance of such pictures. I now pass on to the important question of how they are produced. Moser suggested fifty years ago that there was "dark light," which gave rise to pictures on polished metallic plates, and lately it was suggested that pictures were produced by vapor given off by the metals themselves; the explanation, however, which I have to offer you is, I think, simpler than either of these views, for I believe that the action on the photographic plate is due to the formation of a well-known chemical compound, hydrogen peroxide, which, undergoing decomposition, acts upon the plate and is the immediate cause of the pictures formed. The complicated changes which take place on the sensitive plate I have nothing to say about on the present occasion, but I desire to convince you that this body, hydrogen peroxide, is the direct cause of these pictures produced in the dark. Indirect proof has to be resorted to. Water cannot be entirely excluded, for an absolutely dry photographic plate would probably be perfectly inactive, and as long as water is present, peroxide of hydrogen may be there also. But what are the conditions under which these pictures are formed? Only certain metals are capable of producing them. This list of active metals which I have mentioned to you was determined solely by experiment, and when completed it was evident that it was not common property that bound them together. Now, however, the explanation has come, for these are the very metals which most readily cause, when exposed to air and moisture, the formation of this body, peroxide of hydrogen. Schönbein showed, as long ago as 1860, that when zinc turnings were shaken up in a bottle with a little water, hydrogen peroxide was formed, and the delicate tests which we now know for this body show that all the metals I named to you not only can in the presence of moisture produce it, but that their power of doing so follows the same order as their power of acting on a photographic plate. Again, what happened with regard to the organic bodies which act on the photographic plates? I have already mentioned that in experimenting with the metals it was accidentally observed that copal varnish was an active substance producing a picture like that produced by zinc, and that the action was traced to the turpentine present. Again, a process very much like groping in the dark had to be carried on in order to determine which were active and which inactive organic bodies, and the result obtained was that the active substances essentially belonged to the class of bodies known to chemists as terpenes. Now a most characteristic property of this class of bodies is that in presence of moisture and air they cause the formation of hydrogen peroxide, so that whether a metal or an organic body be used to produce a picture, it is in both cases a body capable, under the circumstances, of causing the formation of hydrogen peroxide. Passing now to experimental facts, which confirm this view of the action on sensitive plates, I may at once say that every result obtained by a metal or by an organic body can be exactly imitated by using the peroxide itself. It is a body now made in considerable quantity, and sold in solution in water. Even when in a very dilute condition it is extremely active. One part of the peroxide diluted with a million parts of water is capable of giving a picture It can, of course, be used in the glass dishes like any other liquid, but it is often convenient not to have so much water present; and then it is best to take white blotting paper, wet it in the solution of the peroxide, and let it dry in the air. The paper remains active for about twenty-four hours; or, what is still better, take ordinary plaster of paris, wet it with the peroxide solution, and let it set in a mold so as to get a slab of it. This slab increases in activity for the first day or two after making, and retains its activity for a fortnight or more. Such a slab will give a good and dark picture in three or four seconds.

To show how similar the pictures produced by the peroxide and those by zinc are, pictures of a Japanese paper stencil, which had been paraffined to make it quite opaque, have been made by both processes, and are shown with other instances in which turpentine was used in the following slides. It is also very easy to obtain good pictures with the peroxide alone of the structure of paper, etc.; see, for instance, this one of a five-pound note, and these of lace. Again, the strict similarity between the action of the peroxide and that of the metals and organic bodies is further shown by the fact that its action passes through the same media as their action does; and here are good pictures formed by the action of the peroxide after passing through a sheet of these substances. How this singular transmission can be explained I have treated of elsewhere, and time does not allow of my discussing the matter to-night.

There are many ways in which the bright active zinc surface can be modified. Draw your finger across it, press your thumb upon it, and you stop its activity, as is shown by the picture it will give. Lay a printed paper on the zinc, and let the contact continue for three-quarters of an hour, at a temperature of 55°, then bring the zinc in contact with a sensitive plate, a picture of the printing is formed; but allow the contact between the zinc and printing to continue for eighteen hours at the same temperature, and the picture then given by the zinc is the reverse of the former one. Where the ink has been is now less active than the rest of the plate. Here are slides which show these positive and negative pictures. Another way of modifying the zinc surface is interesting. You have seen that the ordinary zinc surface which has been exposed to air and moisture is quite inactive, but if a bright piece of zinc be immersed in water for about twelve hours the surface is acted on; oxide of zinc is formed, showing generally a curious pattern. Now, if the plate be dried, it will be found that this oxide is strongly active, and gives a good picture of the markings on the zinc. The oxide evidently holds, feebly combined or entangled in it, a considerable quantity of the hydrogen peroxide, and it requires long drying or heating to a higher temperature to get rid of it. Also, if a zinc plate be attacked by the hydrogen peroxide, the attacked parts become more active than the bright metal. Thus place a stencil on a piece of bright zinc and expose the plate to the action of an active plaster of paris slab, or to active blotting paper for a short time, then, on removing the stencil, the zinc plate will give a very good picture of the stencil.

Any inactive body—for instance, a piece of bristol board or any ordinary soft paper—can be made active by exposing it above a solution of peroxide, or, more slowly, by exposing it to a bright zinc surface. If, for instance, a copper stencil be laid on a piece of bristol board and a slab of active plaster of paris be placed on the stencil for a short time, the bristol board will even, after it has been removed from the stencil for some time, give a good picture of the stencil. Drying oil and other organic bodies may be used in the same way to change the paper. A curious case of this occurred in printing a colored advertisement cut out of a magazine, for there appeared printing in the picture which was not in the original. This printing was traced to an advertisement on the opposite page, which had been in contact with the one which was used; thus this ghostly effect was produced.

I believe, then, that it is this active body, hydrogen peroxide, which enables us to produce pictures on a photographic plate in the dark. There are many other curious and interesting effects which it can produce, and which I should like to have shown you, had time permitted.

REPORT OF THE COMMISSIONER OF PATENTS TO CONGRESS FOR THE YEAR ENDING DECEMBER 31, 1899.

Department of the Interior,
United States Patent Office,
Washington, D. C., January 31, 1900.

To the Senate and House of Representatives of the United States of America in Congress assembled:

In compliance with Section 494 of the Revised Statutes, I have the honor to submit the following report of the business of the Patent Office for the year ending December 31, 1899:

RECEIPTS AND EXPENDITURES.

Receipts from all sources	$1,325,457 03
Expenditures	1,211,783.73
Surplus	$113,673.30

Statement of balance in the Treasury of the United States on account of the patent fund.

Amount to the credit of the fund January 1, 1899	$4,972,976.34
Amount of receipts during the year 1899	1,325,457.03
Total	$6,298,433 37
Deduct expenditures for the year 1899	1,211,783.73
Balance January 1, 1900	$5,086,649.64

SUMMARY OF THE BUSINESS OF THE PATENT OFFICE.

Number of applications for patents for inventions	38,937
Number of applications for patents for designs	2,400
Number of applications for reissues of patents	106
Total number of applications	41,443
Number of caveats filed	1,716
Number of applications for registration of trade-marks	2,059
Number of applications for registration of labels	629
Number of applications for registration of prints	143
Number of disclaimers filed	1
Number of appeals on the merits	952
Total	5,500
Total number of applications, etc., requiring investigation and action	46,943
Number of patents issued, including designs	25,435
Number of patents reissued	92
Total	25,527
Number of trade-marks registered	1,649
Number of labels registered	511
Number of prints registered	100
Total	2,260
Number of patents expired during the year	18,135
Number of patents withheld for non-payment of final fees	3,097
Number of applications allowed awaiting final fees	8,037

In 1899 there were received 38,937 applications for patents, 2,400 applications for designs, 106 applications for reissues, 2,059 applications for registration of trade-marks, 629 applications for registrations of labels, and 143 applications for registration of prints. There were 25,435 patents granted, including designs, 92 patents reissued, 1,649 trade-marks registered, and 511 labels and 100 prints. The number of patents that expired was 18,135. The number of allowed applications awaiting the payment of final fees was 8,037. The number that were forfeited for non-payment of the final fees was 3,997. The total expenditures were $1,211,783.73. The receipts over expenditures were $113,673.30. The total balance to the credit of the Patent Office in the Treasury of the United States on January 1, 1900, was $5,086,649.64.

In proportion to population more patents were issued to citizens of Connecticut than to those of any other State—1 to every 945 inhabitants. Next in order are the following: District of Columbia, 1 to every 1,151; Massachusetts, 1 to every 1,262; Rhode Island, 1 to every 1,270; Oklahoma Territory, 1 to every 1,344; New Jersey, 1 to every 1,455; Montana, 1 to every 1,474; New York, 1 to every 1,579; Colorado, 1 to every 1,604; California, 1 to every 1,652. The fewest patents granted in proportion to the number of inhabitants were in the following States: South Carolina, 1 to every 25,024; North Carolina, 1 to every 21,012; Alabama, 1 to every 17,195; Georgia, 1 to every 14,025, and Mississippi 1 to every 13,574.

As to foreign patents, 1,072 patents were granted to residents of England; 888 to those of Germany; 371 to those of Canada; France, 292; Austria-Hungary, 100; Scotland, 83; Switzerland, 73; Belgium, 65; Sweden, 45; Victoria, 43; New Zealand, 41; New South Wales, 32; Ireland, 27; Russia, 25; Italy, 23; Denmark, 20; Mexico, 14; Netherlands, 13; South Australia, 10; South African Republic and Western Australia, 7 each; Norway, 6; Argentina, Queensland, and Tasmania, 5 each; India and Jamaica, 4 each; Finland, Japan, and Java, 3 each; Guatemala, Peru, Turkey, and Uruguay, 2 each, and Algeria, Bermuda, Brazil, Bulgaria, Cape Colony, Chile, China, Danish West Indies, Dutch West Indies, Egypt, Island of Tahiti, Spain, Sumatra, Trinidad, and Venezuela, 1 each.

THE WORK OF THE OFFICE.

The examining work of the office has been kept well in hand during the year. On December 27, 1898, there were 5,467 applications awaiting action, while on December 26, 1899, 5,392 application were awaiting action,

On December 27, 1898, two divisions were examining applications filed within one month thirty-three divisions those filed within two months, and one division those filed within three months, while on December 26, 1899, thirty-three divisions were examining applications filed within one month, and three divisions those filed within two months. At both dates substantially all of the divisions were taking up amended cases for action within fifteen days after the amendments were filed.

This is a most excellent showing when the disadvantages under which the work is being done are taken into account. The lack of suitable room greatly hampers and unnecessarily delays the work in many divisions.

During the year the work of the clerical divisions has been kept well in hand. The work of furnishing printed copies of specifications and drawings of patents has been placed under the control of one person, and the system adopted by him has been such that single copies have been much more promptly furnished and the class orders are now being filled within a week, where a year ago they were often not filled within three months. With sufficient room to properly arrange these printed copies orders for them could be filled almost as soon as received.

THE CLASSIFICATION DIVISION.

In my annual report for the calendar year 1898, I stated that a classification division had been organized, but that the work had not progressed far enough to enable the office to determine the best system in all of its details. I am now able to report progress and outline the system adopted.

During the present year considerable progress has been made in the work, but owing to the lack of room the work has been hampered, as it will continue to be until additional space becomes available, as it will when the General Land Office removes from the Patent Office building.

One of the first steps taken was to rearrange the original drawings of all patents in numerical order. The object of this was to economize our storage space and to make it possible to find any given patent at a moment's notice. Formerly the drawings were arranged by subclasses, and as it was necessary to know the classification of a patent before it could be found a long search was often necessitated. The first ten thousand patents had no numbers and were identified only by name and date. This involved additional labor to properly arrange them. The numerical arrangement of the original drawings of nearly seven hundred thousand patents and trade-marks has been completed and lists of patents issued without drawings, and of drawings which have not been found are now being made. When this is completed, the patents for which there are no drawings will be represented by dummies containing the number of the patent and a statement as to whether there were any drawings or whether the same have been lost. These dummies will be filed in their appropriate relation with the original drawings for the purpose of preserving the record.

The classification proper has meanwhile been carried on. One division consisting of eight main classes has been completely classified, and from one to three classes in nine other divisions have been completely or partially classified.

The following plan of classification has been adopted:

Under the provisions of Section 4,886 of the Revised Statutes a patent is to be granted only when the invention was not known or used by others nor patented or described in any printed publication prior to the invention thereof by the applicant. To ascertain these facts, a search must be made.

The present field of search, which increases greatly every year, consists of about 700,000 United States patents, 1,250,000 foreign patents, and 74,000 volumes of scientific works in the Patent Office Library.

It is the object of classification to reduce this immense mass of matter to classes and subclasses of convenient size, capable of clear separation and definition and based upon a system sufficiently elastic to provide for future growth. Without such classification it would be impossible to examine the 40,000 applications filed annually, or to make researches of sufficient accuracy to justify the treatment of a patent as prima facie evidence of its validity. Inability to make accurate searches also renders uncertain property rights to the amount of millions of dollars and menaces the security of all manufacturing interests based upon patents.

The first and most difficult step in classification is the separation of the subject matter into main classes of a character that will bring together such inventions as are similar in structure and analogous in their use, both of which elements are essential in their citation as references in the rejection of an application for a patent.

In order that there may be a certainty in placing a patent in its proper class, the first rule to be observed is that wherever there is liability to conflict between two or more classes one will be fixed upon as the superior class and all the others which are related thereto will be treated as inferior classes. This being settled, all patents which contain more than one invention or which cover a construction which combines in a single apparatus or machine the subject-matter of two or more classes are placed in the superior class, and when necessary the inferior classes are completed by placing therein copies of these patents, which are known as cross references.

The various kinds of main classes are as follows and rank according to number:

MACHINES.

1. Combination machines, or such as perform more than one operation. 7. Functional machine classes, which are defined by the character of the operation performed. 6. Material machine classes which are limited to operation upon some particular material. 4. Article machine classes, which are used solely in the making of a specific article and incapable, without considerable change, of any broader or more general use. 5. Functional material machine classes, which are functional machines limited further by the material operated upon. 3. Functional article machine classes, which are functional machines limited to the making of a specific article. 2. Material article machine classes, which are material classes limited to the making of a specific article. 8. Machine elements, which are mechanical movements or parts which may be found in any class of complete machines.

ARTICLES OF MANUFACTURE.

Articles of manufacture are divided into (1) finished articles, (2) structural materials, and (3) compositions of matter, ranking in the order named. They are only occasionally numerous enough to constitute main classes and are generally grouped according to their function or use and placed in classes with the machines for making them.

PROCESSES OR METHODS.

Processes or methods are divided into (1) machine processes and (2) article processes, according as they are most closely related to the machine or the product, and they are placed in the same classes with them.

Having formed proper main classes, the material is next separated into finer divisions, called "subclasses."

The machine composing the class will be divided into general utility and special article making machines, the subclasses of special article making machines being superior to those of the general utility group, as indicated by the figures on the left. Each of these groups is then divided into combination and single operation machines, the meaning of which has been before explained. The combination machine classes are distinguished by titles indicating the number and character of the operations performed, as "turning and sawing," "boring and tenoning," etc.

The single operation machines of the general utility group are divided into subclasses ranking as follows: Miscellaneous; Structural type subclasses, which are complete machines of a definite type, as "horizontal boring mills;" major-structure subclasses, which are important portions of a machine, and minor structure subclasses, which are less important parts and which may be included in the superior subclasses.

The machines, both combined and single operation, of the special article, making, group are formed into art classes, their names indicating the article made, as "clothespin machines."

CROSS-REFERENCING.

Cross-referencing, as before explained, when necessitated by mixed matter, is always from the lowest-numbered or superior subclasses into the inferior or higher-numbered one.

In some cases cross referencing is necessary because certain structural features are common to two or more classes or subclasses, and in these cases it may be carried into either or both directions, as desired.

SEARCH CARDS.

When it would be necessary to cross-reference a considerable portion of one subclass into another, a search card is used instead. This is a card stamped with the title of the subclass in which it is to be placed and containing printed directions to search any other subclasses from which cross-references would otherwise have been drawn.

PRESERVATION OF CLASSIFICATION.

In order that the lost copies of patents may be replaced in the files used in searching by the examiner and the public and to prevent unauthorized changes in the classification, the following records are made:

After a patent has been classified, and also when a new patent is issued, it is stamped by the classification division with the number and title of its appropriate class and subclass. A card is then prepared, giving the number of the patent and the name of the inventor, and this also is stamped with the proper class and subclass. When brought together in their proper subclasses, these cards constitute a subclass card-index, which will enable the classification division to check up any subclass and replace any lost copies. Each of these cards also shows whether the patent is cross-referenced into other subclasses, and the patent is represented in those subclasses by a similar card headed with the word "Cross-Reference."

A numerical list of all the patents issued is also kept in the classification division, and the classification of each patent as soon as it is made is entered on this list, so that it can always be ascertained where any patent is placed.

If the classification of any patent is to be changed, the classification division is notified, and, if the change is approved, will make a new subclass card, destroy the old one, and change the classification on the numerical list. As all changes must be made, and all stamping done by the classification division, no unauthorized changes can occur.

Printed publications will not be taken up until the patents are all reclassified, except in the case of chemical bodies and compositions of matter, which are being embodied in a card-index, and which will be a valuable supplement to the patent classification.

ROOM.

The expectation expressed in my last annual report that "in a few months some additional room will be placed at our disposal" has not yet been realized. The work of the office in all of its branches is hampered by the lack of necessary room. Even when the General Land Office vacates the Patent Office building, room sufficient for the necessary work of the office will not be available. The business of this office increases from year to year and, consequently, the necessity for more space, especially for storage purposes, cannot be too strongly emphasized. Some of these records constitute the legal evidence of title of many of the large manufacturing industries of the country, while others disclose the proceedings in this office when the applications for the issued patents were pending, and it is self-evident that all of these should be preserved in a fireproof building. Their loss would work an incalculable injury not alone to the owners of the patents, but the public in general.

The American Society of Mechanical Engineers, the Patent Bar Association of Chicago, the National Association of Agricultural Implement and Vehicle Manufacturers, as well as other organizations and individuals, have forcefully called to the attention of your honorable bodies the necessity for such a building.

I commend to your careful consideration and heartily approve of Senate Bill No. 1,159, which provides for the construction of a "fireproof building, for the use and accommodation of the Patent Office of the United States, including a Hall of Inventions."

It is now almost universally recognized that this country owes a debt of gratitude to its inventors and progressive manufacturers. In view of the well-known fact that the inventors of the country have paid all of the expenses of carrying on the Patent Office, and that this office has covered into the Treasury over five millions of dollars in excess of all expenditures, no more fitting way of recognizing the value of the patent system to the country can be found than by using this money for the erection of a suitable building in which the business of the office can be conveniently and safely carried on, and at the same time giving ample space for illustrating the growth of the industrial arts by means of suitable models.

THE SCIENTIFIC LIBRARY.

The efficiency and accuracy of the work of this office depend to a considerable degree upon its library. It should be kept abreast of the progress in the mechanical and manufacturing arts of the day, and to that end ample appropriations should be made. For years the appropriation for this library has been inadequate. Every effort made to increase it has failed, and authority has been denied to the Commissioner of Patents to dispose of such publications therein contained as are of no special value in its special field and to use the proceeds in the purchase of modern works. No sound reason can be advanced why this authority should not be given.

DESIRED LEGISLATION.

Nothing has impressed me more forcibly during the two years in which I have occupied the position of Commissioner of Patents than the advisability and necessity of limiting the number of appeals in "merit" and "interference" cases. Under the present status if an application is rejected by the Principal Examiner an appeal lies to the Board of Examiners-in-Chief, and from that tribunal to the Commissioner of Patents in person, and from him to the Court of Appeals of the District of Columbia.

In interference proceedings the appeals are the same, save that the first appeal is from the Examiner of Interferences. These various appeals necessarily delay the issue of patents, whereby the rights of the public are prejudiced in that the monopoly does not begin to run until the actual issue of patent. The applicants for patents are put to heavy expenses, which to many are a grievous burden.

In my opinion there should be but one appeal in the Patent Office and no appeal to the Court of Appeals of the District of Columbia. The reason why there should be no appeal to the court is that under Section 4915 of the Revised Statutes the applicant to whom a patent is refused can prosecute his application in another court and an aggrieved party in an interference proceeding can renew his contest in another court.

I suggest an amendment to the statutes by which the Board of Examiners-in-Chief be abolished and that in their place and in the place of the present Assistant Commissioner there be three Assistant Commissioners appointed who, together with the Commissioner, shall be persons of competent legal knowledge, scientific ability, and well versed in patent law, and shall hear all appeals from the Primary Examiner and Examiner of Interferences. The Commissioner, with any two of the Assistant Commissioners or the three Assistant Commissioners shall have the power to review and determine upon all adverse decisions made by the Principal Examiners upon applications for patents and for reissue patents and the decisions of the Examiner of Interferences on all questions relating to priority of invention. Such a system will lead to an early decision of the question, limit the number of appeals, thereby relieving inventors from an unnecessary burden, and will end the anomalous condition which now exists, in that one person—the Commissioner of Patents—reviews the decisions made by a board composed of three. Under the present statutes the decisions of the Board of Examiners-in-Chief have not that force and effect that they ought, for the reason that all their decisions are not final and are largely treated in "merit" cases as only applying to the case in hand. The Assistant Commissioners should be appointed for a definite term of years, say six, (the first appointments, however, to be respectively for two, four, and six years).

While the question of politics manifestly should not and does not to any extent enter into the conduct of the Patent Office, yet in order to overcome any objections that might be offered on that score provision might be made that not more than two of them should be appointed from the same political party.

In view of the fact that aside from the judicial duties of the Commissioner he has to perform executive duties, it may be urged that he should be in harmony with the administration, and therefore it may be thought best that no change in the manner of his appointment be made.

A bill embodying these features has been introduced, and its enactment as a law will, in my opinion, be beneficial to the patent system.

At the present time an application can be kept alive in the office for an indefinite number of years, although there is no good reason why at least ninety per cent. of all patents cannot be issued within one year after filing applications therefor. The practice of keeping applications pending in the Patent Office is, in my opinion, reprehensible, as it certainly does not promote the progress of invention, but rather tends to stifle it. If an application does not become involved in an interference, it should not be permitted to remain in the Patent Office more than three years without abridging its life of seventeen years. Were it not for the number of appeals, all interferences could be disposed of within that time. To meet any case of unusual hardship, discretion might be lodged with the Commissioner of Patents to extend the proposed limit of three years.

The Trade-mark Statutes should be amended so as to provide for the registration of the trade-marks used in interstate commerce. Other amendments are required; but as this subject is being dealt with by the commission appointed in 1898 I refrain from making any further suggestions upon this point.

I am informed that the commissioners appointed under act of Congress approved June 4, 1898, to revise the statutes relating to patents, trade and other marks, etc., recently submitted to Congress a preliminary report comprising a large number of documents bearing on the treaties and conventions between the United States and foreign nations regarding patents and trade-mark protection on some special features of foreign patent and trade-mark laws and on the history of trade-mark legislation in the United States.

I understand that this preliminary report is to be followed shortly by a full report which will include a review of the arrangements entered into between the United States and foreign nations, and between foreign nations with respect to patents and trade-marks, of foreign patent and trade-mark laws, and of trade-mark protection in the United States, and will include propositions for such changes in the statutes as are required to give effect to treaty stipulations, as well as such changes as will incorporate into our laws such provisions of foreign patent and trade-mark laws as are deemed advantageous to the public interest and in harmony with our institutions. A feature of this report which is of particular interest will be a proposed revision of the trade-mark law to provide for the registration of trade-marks used in interstate commerce and to encourage a more general registration of trade-marks by reducing the registration fee.

President McKinley in his annual message of December 5, 1899, says:

"Our future progress and prosperity depend upon our ability to equal, if not surpass, other nations in the enlargement and advance of science, industry, and commerce. To invention we must turn as one of the most powerful aids to the accomplishment of such a result."

May not our inventors hopefully look to the Fifty-sixth Congress for aid and effectual encouragement in improving the American patent system?

C. H. DUELL, Commissioner.

SEARCH FOR MERCURY IN THE PRODUCTS OF VINES TREATED WITH MERCURIAL MIXTURES.*

CORROSIVE sublimate having been recently recommended for the cryptogamic maladies of the vine, and in particular black rot, we instituted in Beaujolais, experiments with this salt, in different quantities, for the purpose of testing the effects attributed to it.

Mercury and its compounds being regarded as poisons, it appeared to be of interest to seek for it in the products of vines treated with mercurial mixtures for black rot. Its presence in wine in noticeable quantity would evidently be a fatal obstacle in grape culture, whatever might be its action against the diseases of the vine.

We sought for mercury in the draught wine, press wine, the lees, the residuum, and in one case the grapes themselves, proceeding with vines treated with the following mixtures:

1. Cupric sulphate, 2 kilograms; fat lime, 2 kilograms; sublimate, 100 grains; water, 100 liters.
2. Cupric sulphate, 2 kilograms; fat lime, 2 kilograms; sublimate, 50 grains; water, 100 liters.
3. Sublimate, 50 grains; starch, 500 grains (as a fixer); water, 100 liters.

The process of analysis which we followed is that which was recently suggested by M. Barrillot, and one of us.

The grapes were first washed two or three times with plenty of distilled water, with the aid, when necessary, of a soft brush, in order to dissolve soluble metallic compounds. There was an hour of digestion each time, then thorough washing twice, with an aqueous solution of 10 per cent. aqua regia, oxidizing and dissolving the metals otherwise insoluble, with two hours of digestion each time.

The wines were filtered in order to separate the lees.

The lees, separated from the clear wine, were treated with 10 per cent. of pure water.

The residuum was first washed two or three times with distilled water, then with 10 per cent. aqua regia, in the same way as the grapes.

The aqueous liquor and the clear wines were then acidulated with 1 per cent. aqua regia and the acid liquors saturated to nine-tenths of their acid by NaOH before their precipitation by H_2S.

The following table gives in milligrams the weights of mercury found:

FIRST MIXTURE.

	Total mercury.	Per liter.
Draught wine	0 mg.	
Lees of draught wine proceeding from 1 liter	0·6 "	
Press wine	0·3 "	
Lees of press wine proceeding from 1 liter	0·6 "	
Mercury per kilogram.	Soluble.	Insoluble.
Residuum ..... traces less than.	0·37 mg.	2·06 mg.

SECOND MIXTURE.

	Total mercury.	Per liter.
Draught wine	0 mg.	
Lees of draught wine proceeding from 1 liter	0 "	
Press wine ..... traces less than.	0·3 "	
Lees of press wine proceeding from 1 liter ..... traces less than.	0·3 "	
Mercury per kilogram.	Soluble.	Insoluble.
Residuum ..... traces less than.	0·3 mg.	1·3 mg.

THIRD MIXTURE.

	Total mercury.	Per liter.
Draught wine	traces.	
Lees of draught wine proceeding from 1 liter	1·53 mg.	
Mercury per kilogram.	Soluble.	Insoluble.
Grapes	traces.	2·62 mg.

These analysis show that the products of the fermentation of grapes treated with mercurial mixtures in proportions as stated, contain only minute quantities of mercury, and that consequently they can be used without danger.

If, with reference to health, the utilization of mercury bichloride for the treatment of maladies of the vine does not appear to offer serious inconvenience, the case is not the same if its action on the growth of the plant is considered. Without entering here into the details of the observations we have been able to make, we may be allowed to say that this action is, in our opinion, injurious and sufficient to cause the rejection of the use of corrosive sublimate in the treating the maladies of the vine.

* A paper of Messrs. Leo Vignon and J. Perraud, presented at the French Academy. Translated from La Revue des Produits Chimiques.

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